NORTH SHORE OF LAKE SUPERIOR
REMEDIAL ACTION PLANS

Fish Habitat in the Thunder Bay AOC

April 17th, 2019

Robert Stewart, Reg Nelson and Michelle Willows
Lakehead University

Fish Habitat Impairment (Stage 1)

Loss of submerged and shoreline wetlands/marshes

- Mission Island (52.4 ha)
- Neebing (25.5 ha)
- Chippewa (23.4 ha)
- McKellar Island (11.5 ha)
- Northern Wood (5.0 ha)

Fish Habitat in Lower Kaministiquia River System Severely degraded from dredging and daily dumping of 500,000 bushels of grain screenings in to the river near CPFP mill (Goodier, 1981)

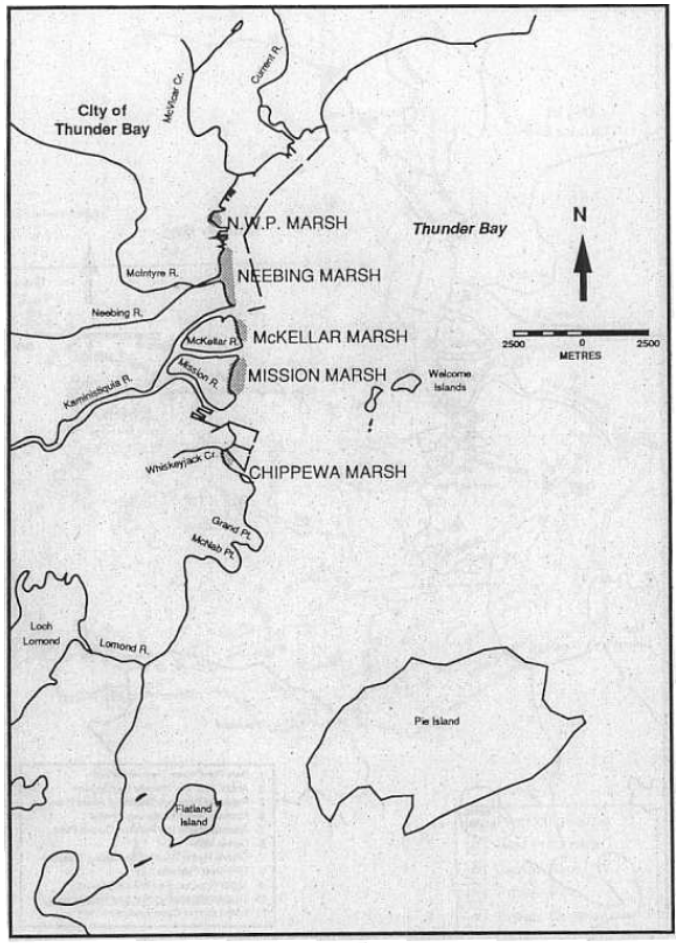


Figure 10:
Thunder Bay Harbour Marshes
(Entwhistle, 1986)

Fish Habitat Impairment (Stage 1)

- Noted Key salmonid habitat in Neebing and McIntyre Rivers and McVicar Creek
- Active Erosion in Kaministiquia River From Water Fluctuation Levels
- Bank Disturbance and Vegetation removal increases run-off and Instream Habitat

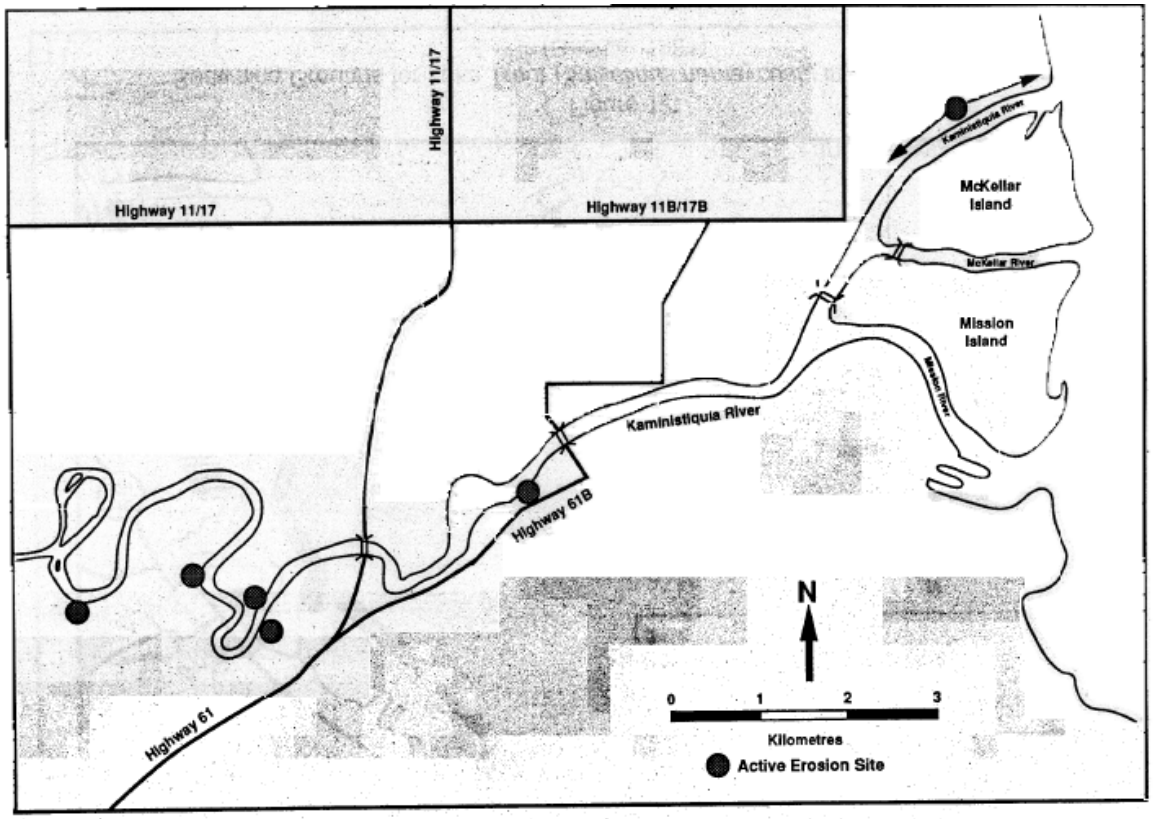


Figure 11:
Kaministiquia River Active Erosion Sites
(Lakehead Region Conservation Authority)

Fish Habitat Impairment (Stage 2 pg. 15)

5. Loss of fish and wildlife habitat

Fish and wildlife habitat remains impaired.

Habitat rehabilitation projects have worked to restore and create nearshore aquatic habitat in five tributaries, rehabilitate the littoral zone, stabilize wetlands, restore riverine diversity, and increase abundance of fish and wildlife populations. Future initiatives that incorporate habitat enhancement and remediation into waterfront development plans should significantly improve habitat value in the AOC.

Fish Habitat Recommendations

The following actions address the first three fish and wildlife population and habitat recommendations, i.e.,

1. Increase the extent of productive aquatic and terrestrial habitat by rehabilitating and protecting wetland and riparian environments, and by enforcing existing environmental legislation.
2. Prevent the loss of aquatic migration corridors.
3. Rehabilitate ecosystem function and structure in order to support a diverse, healthy, self-sustaining biological community. This will ultimately require the virtual elimination of persistent, bioaccumulative and toxic substances (bearing in mind social and economic factors) to ensure that the water quality and sediment conditions in both the lower Kaministiquia River and in Thunder Bay harbour provide a healthy and hospitable environment.

Stage 2 (Table 6.1 pg. 61) Preliminary Criteria

(D) Loss of Fish and Wildlife Habitat	**Target D1:** Increased abundance of walleye using Current River estuary for spawning (double the pre-enhancement (1991) population estimate of 1100 fish); increased egg deposition and fry production. **FWH-1** **Target D2:** Increased diversity and abundance of fish populations in embayment areas of the Neebing-McIntyre Floodway as compared to the unaltered sections of the floodway. **FWH-2** **Target D3:** Protect mouth and shoreline of McVicar Creek from wave action and foster growth and redevelopment of an historic wetland. **FWH-3** **Target D4:** Restore environmental integrity and natural history of the Waterfront Park region on the Kaministiquia River. **FWH-4** **Target D5:** Restore and enhance estuarine habitat diversity in McKellar River; demonstrate rehabilitation method for dredged channel; increase littoral zone and provide critical habitat for resident and migratory fish and birds. **FWH-5** **Target D6:** Restore access to productive spawning habitat; produce a self-sustaining rainbow trout population in the headwaters of the Current River (128 adult rainbow trout were transferred to Ferguson Creek, a tributary of the Current River, between 1993-1995). **FWH-6** **Target D7:** Maintain BOD levels in the Kaministiquia River below MISA discharge limits. **FWH-7** **Target D8:** Standardize aquatic habitat data collection using conventional survey techniques. **FWH-8** **Target D9:** Identify remedial options to address habitat issues in a rural environment; outline preventative measures to protect northern Ontario streams. **FWH-9** **Target D10:** Implement the Slate River Watershed management Plan. **FWH-10** **Target D11:** Re-vegetate areas in vicinity of McVicar Creek, Sanctuary Island and the McKellar River which were disturbed during project construction. Use plants indigenous to the AOC, and produce a natural plant community. **FWH-11**

table 1.4

Delisting Criteria - Loss of Fish Habitat

This beneficial use will no longer be impaired when the following habitat-related projects from the Thunder Bay Stage 2 RAP Report (2004) have been completed, evaluated for effectiveness, and areas support diverse self-sustaining biological communities:

- Alleviation in water quality barriers to fish migration in the Kaministiquia River
- Re-vegetation projects in McVicar Creek and McKellar River
- Island creation and habitat rehabilitation at mouth of McVicar Creek
- Habitat remediation on McKellar River
- Rehabilitation of walleye spawning habitat at Current River Estuary
- Improving salmonid access to the upper reaches of the Current River
- Implement the Slate River Watershed Management Plan
- Identify and assess any remaining point and non-point sources of contaminants, which have contribute significantly to the fish impairments.
- Monitoring to support lake sturgeon rehabilitation strategy
- Implement plan for shoreline naturalization within the Thunder Bay AOC

In addition to the Stage 2 RAP projects, the following should also be completed:

- Remaining and created wetlands are protected from further degradation through existing environmental legislation, with provincial standards used to inventory and classify wetlands within the Thunder Bay AOC
- Provide unrestricted access to critical spawning habitat by providing adequate flow in the Kaministiquia River
- Ensure that native fish populations are not negatively affected by industrial water-use practices, including water intake and discharge

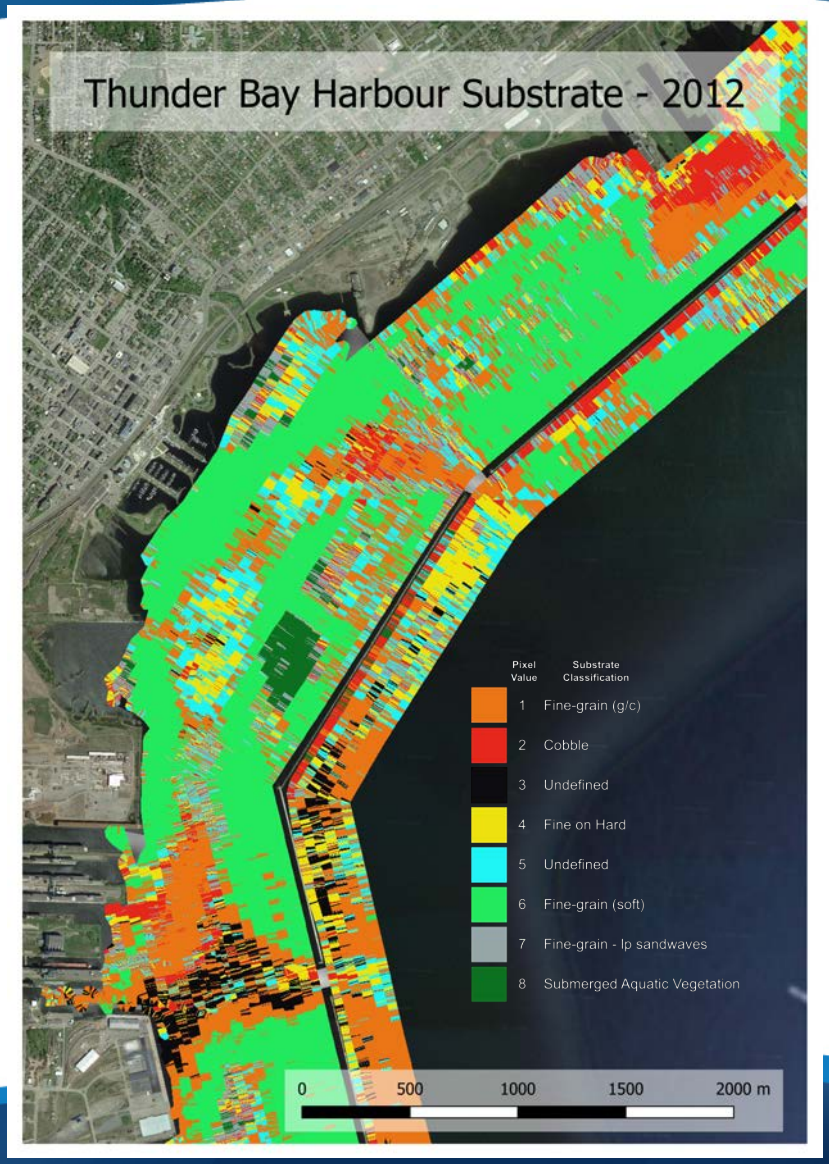
Action (SM-FWH-1): Fish Habitat Classification and Assessment
Status: Planned for 2012
Proponent: Environment Canada with support from Ministry of Natural Resources (Upper Great Lakes Management Unit)
Cost: $30,000

Important information on fish habitat quality and quantity can be determined by identifying and mapping the lakebed characteristics. Assessment of the availability and health of fish habitat in the AOC will indicate the success of previous habitat restoration projects in restoring this beneficial use. This project will provide information about the extent and quality of fish habitat in the form of a ground truthed dataset developed by EC and a summary report reviewed by the MNR. Milestones for this project include:

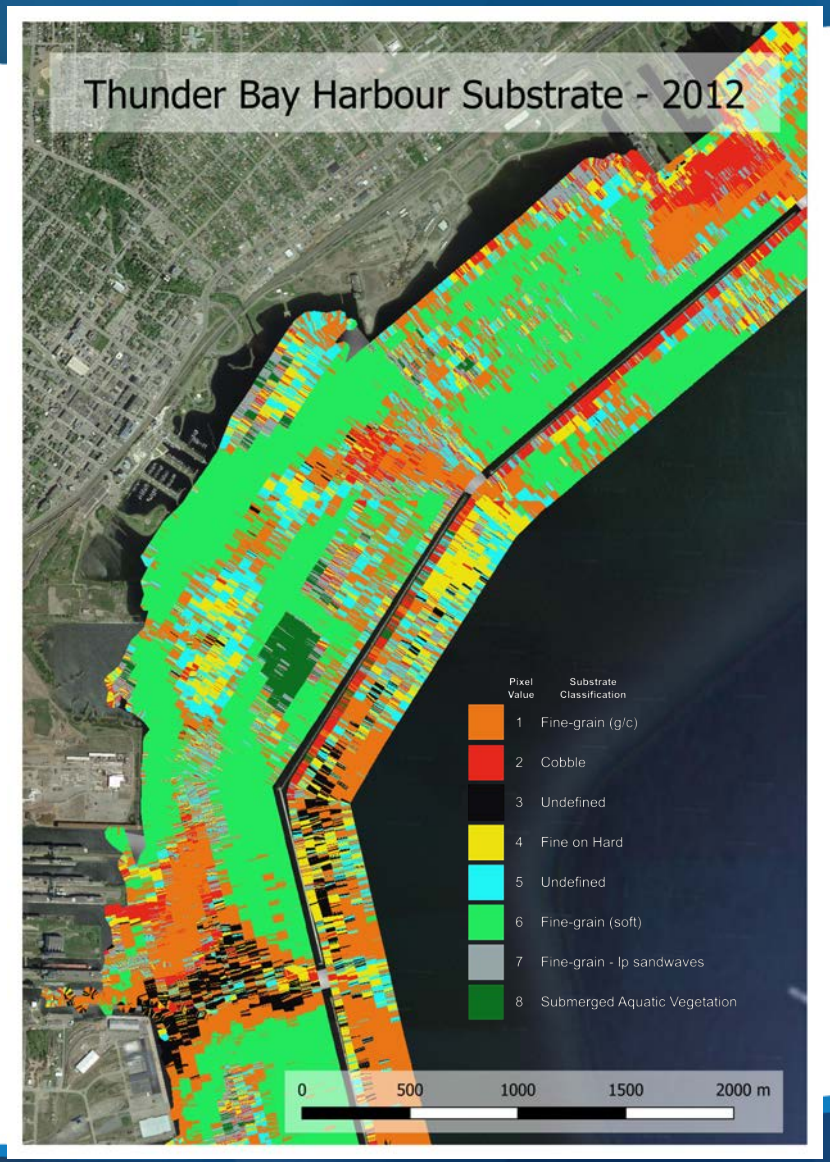
- Completion of monitoring field work for the assessment of the substrate, which will include examining components of cobble and gravel areas for sediment and/or organic material
- Classification and assessment of lake bottom (submerged) substrates to determine the amount of fish habitat for each life stage
- Creation of substrate and bathymetry maps that show fish habitat classification and availability

Thunder Bay Harbour Bathymetry & Substrate – 2012

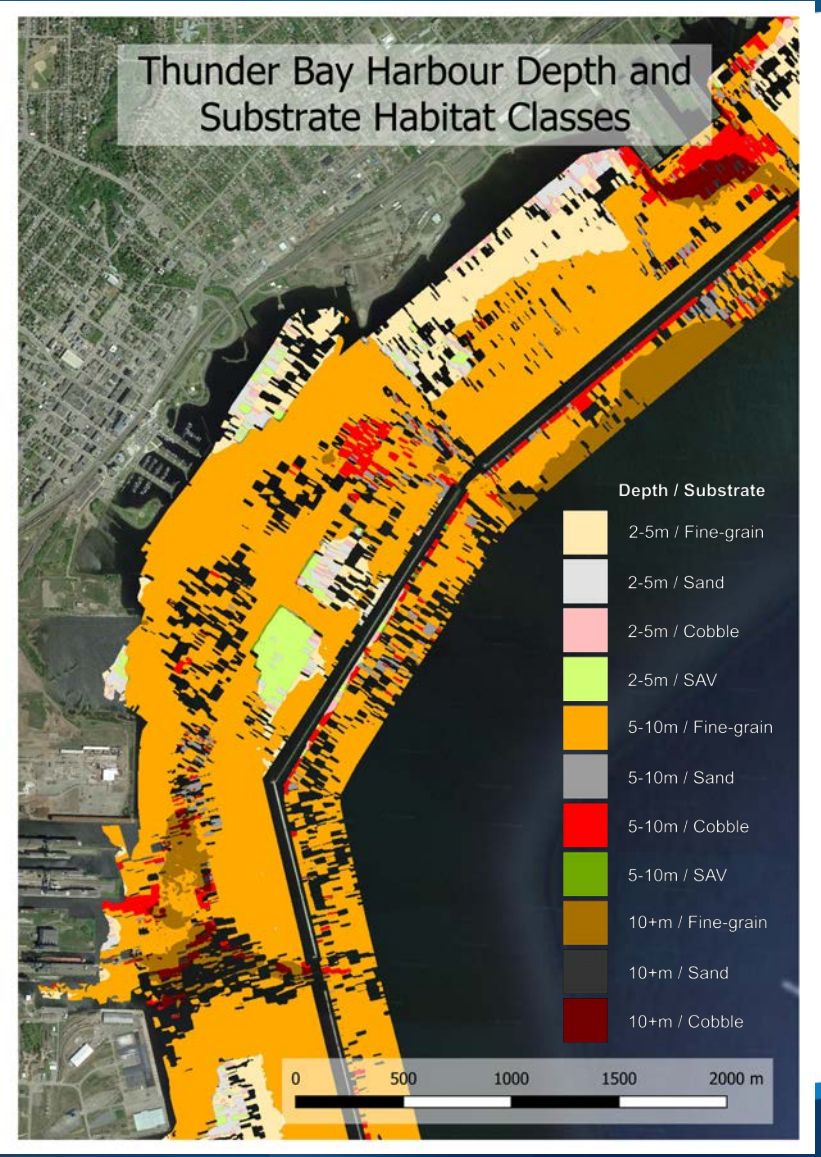
Hans Biberhofer, ECCC



Reclassify Substrate to correspond with unique fish habitat classifications.



Fish Habitat “patches” combining bathymetry and substrate.



Fish Habitat by substrate and depth for Adult, Nursery and Spawning life stages derived from:

Eakins, R. J. 2019. *Ontario Freshwater Fishes Life History Database*. www.ontariofishes.ca

Foster, R. F. 2012. *Thunder Bay North Harbour: Fish Community and Habitat Synthesis.* Northern Bioscience, Thunder Bay

Goodyear, C.S., T.A. Edsall, D.M. Ormsby Dempsey, G.D. Moss, and P.E. Polanski. 1982. Atlas of the spawning and nursery areas of Great Lakes fishes. Volumes I-VIII. U.S. Fish and Wildlife Service, Washington, DC

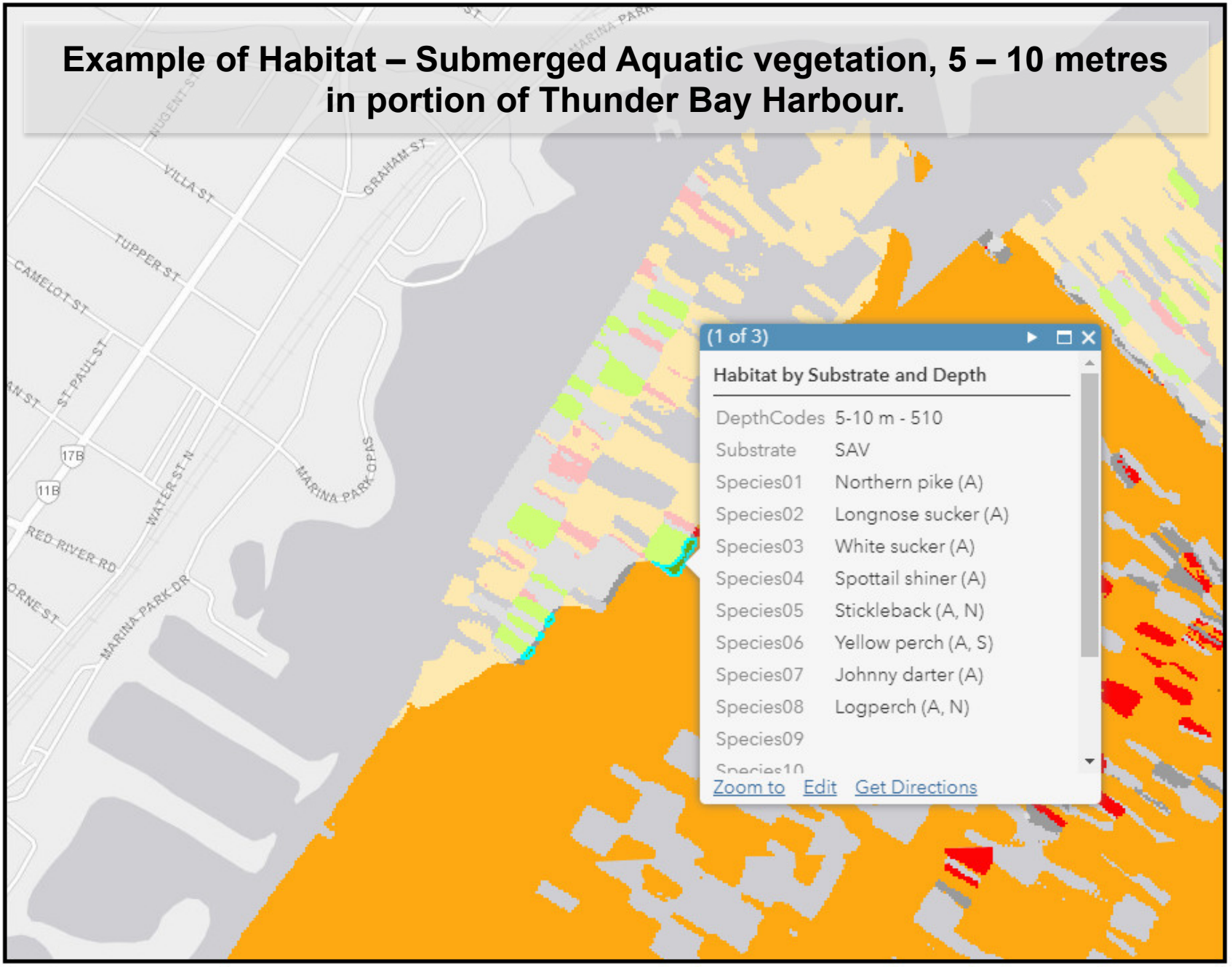
Lane, J. A., Portt, C. B. and Minns, C. K. 1996. Nursery Habitat Characteristics of Great Lakes Fishes. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2338

Lane, J. A., Portt, C. B. and Minns, C. K. 1996. Adult Habitat Characteristics of Great Lakes Fishes. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2358

Lane, J. A., Portt, C. B. and Minns, C. K. 1996. Spawning Habitat Characteristics of Great Lakes Fishes. Canadian Manuscript Report of Fisheries and Aquatic Sciences No. 2368

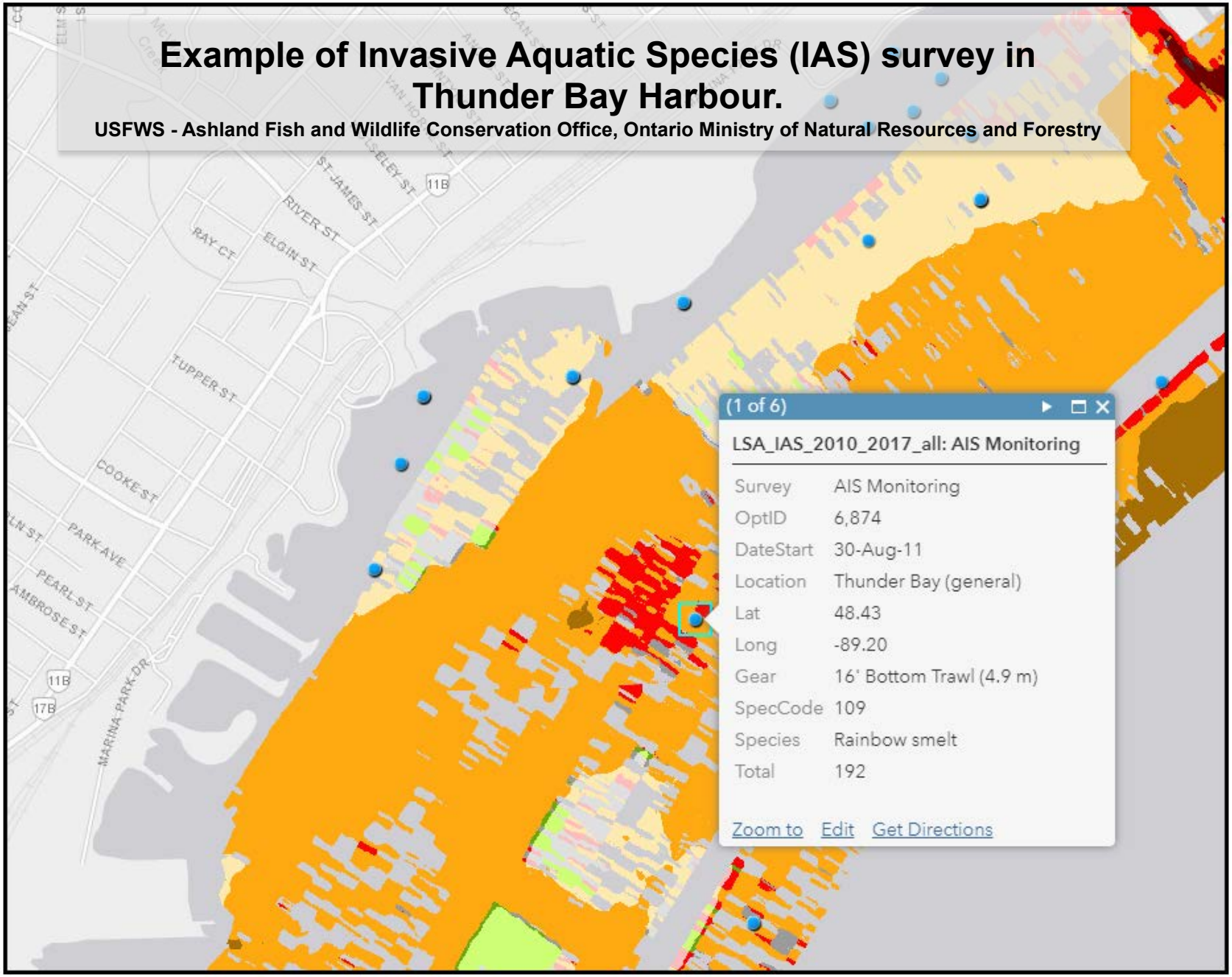
Scott, W. B. and Crossman, E. J. 1973. *Freshwater Fishes of Canada.* Fisheries Research Board of Canada, Ottawa. Bulletin 184.

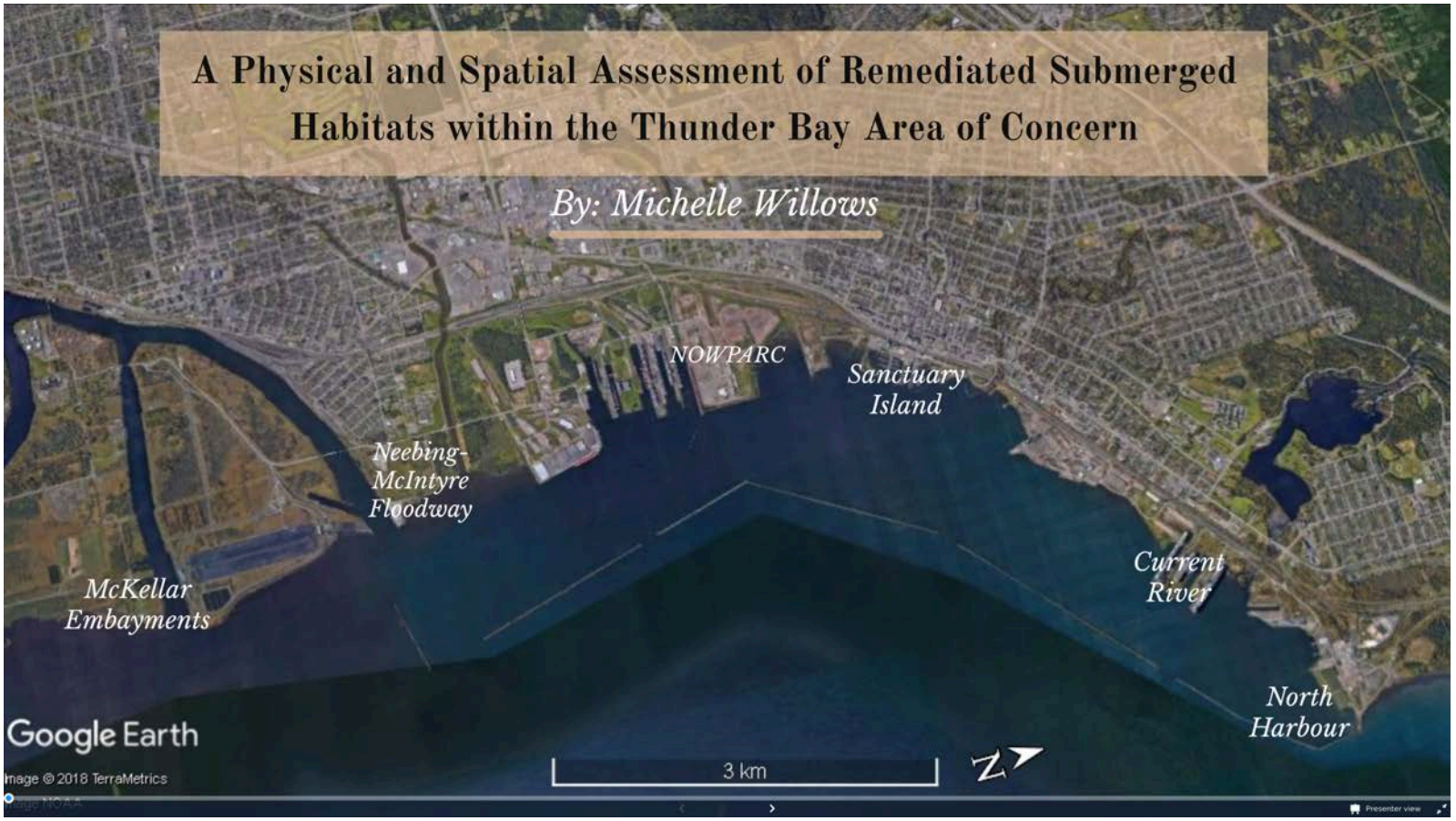
Example of Habitat – Submerged Aquatic vegetation, 5 – 10 metres in portion of Thunder Bay Harbour.



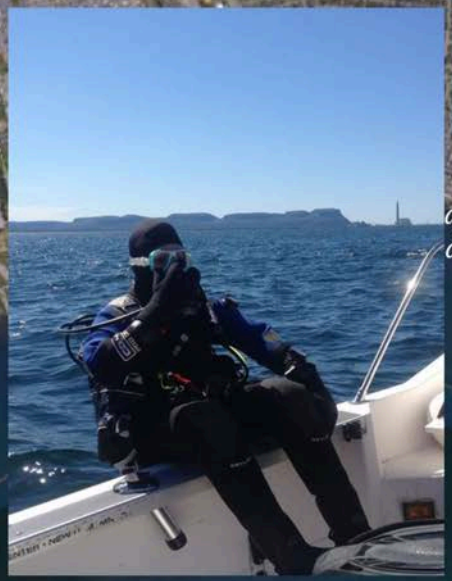
Example of Invasive Aquatic Species (IAS) survey in Thunder Bay Harbour.

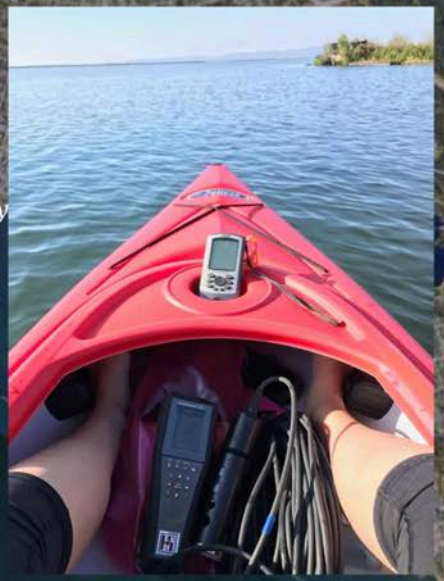
USFWS - Ashland Fish and Wildlife Conservation Office, Ontario Ministry of Natural Resources and Forestry




A Physical and Spatial Assessment of Remediated Submerged Habitats within the Thunder Bay Area of Concern
By: Michelle Willows
NOWPARC
Sanctuary Island
Neebing-McIntyre Floodway
McKellar Embayments
Current River
North Harbour
Google Earth
Image © 2018 TerraMetrics
3 km
N

A Physical and Spatial Assessment of Remediated Submerged Habitats within the Thunder Bay Area of Concern





Google Earth

Image © 2018 TerraMetrics

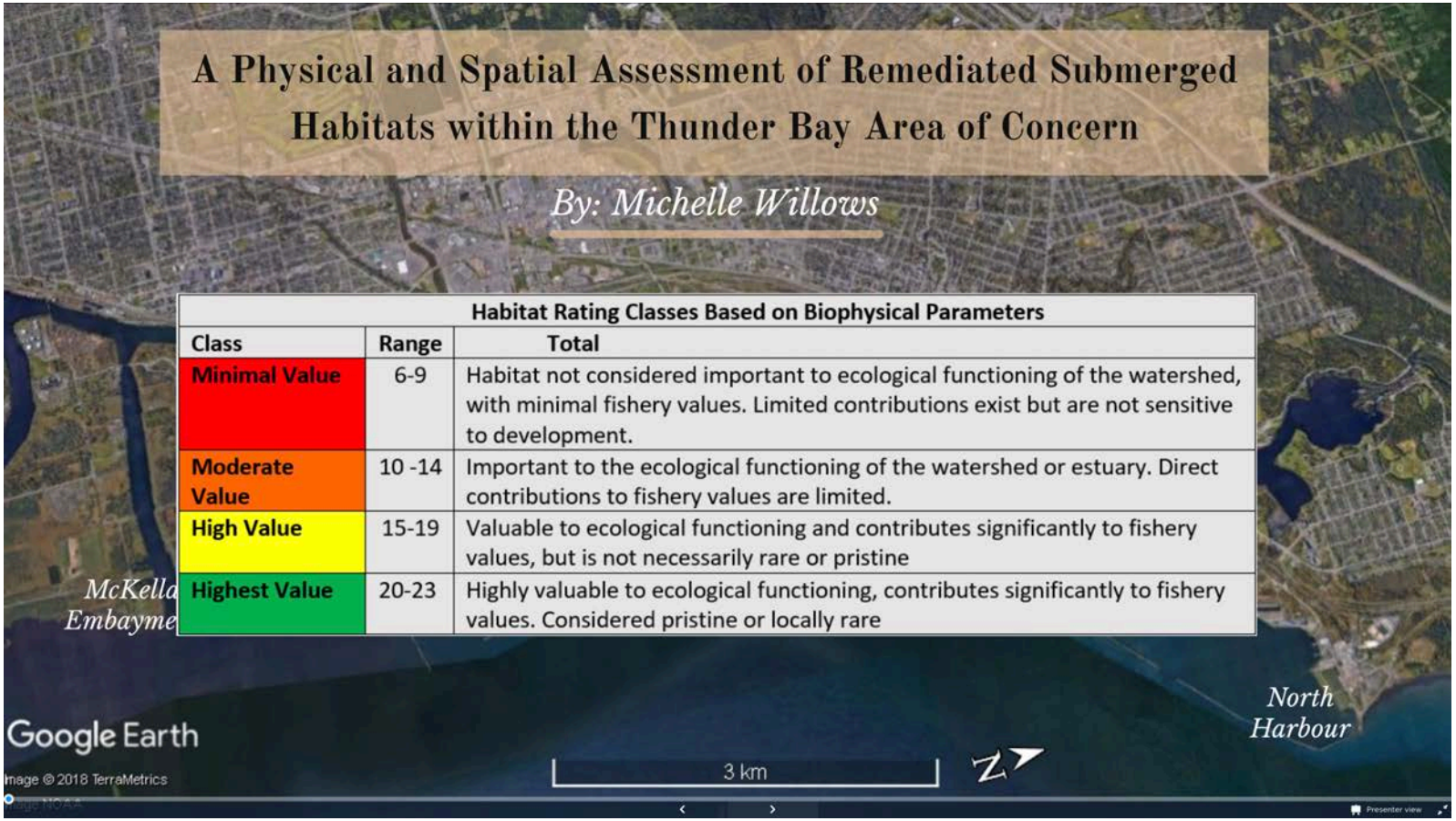
3 km

Harbour

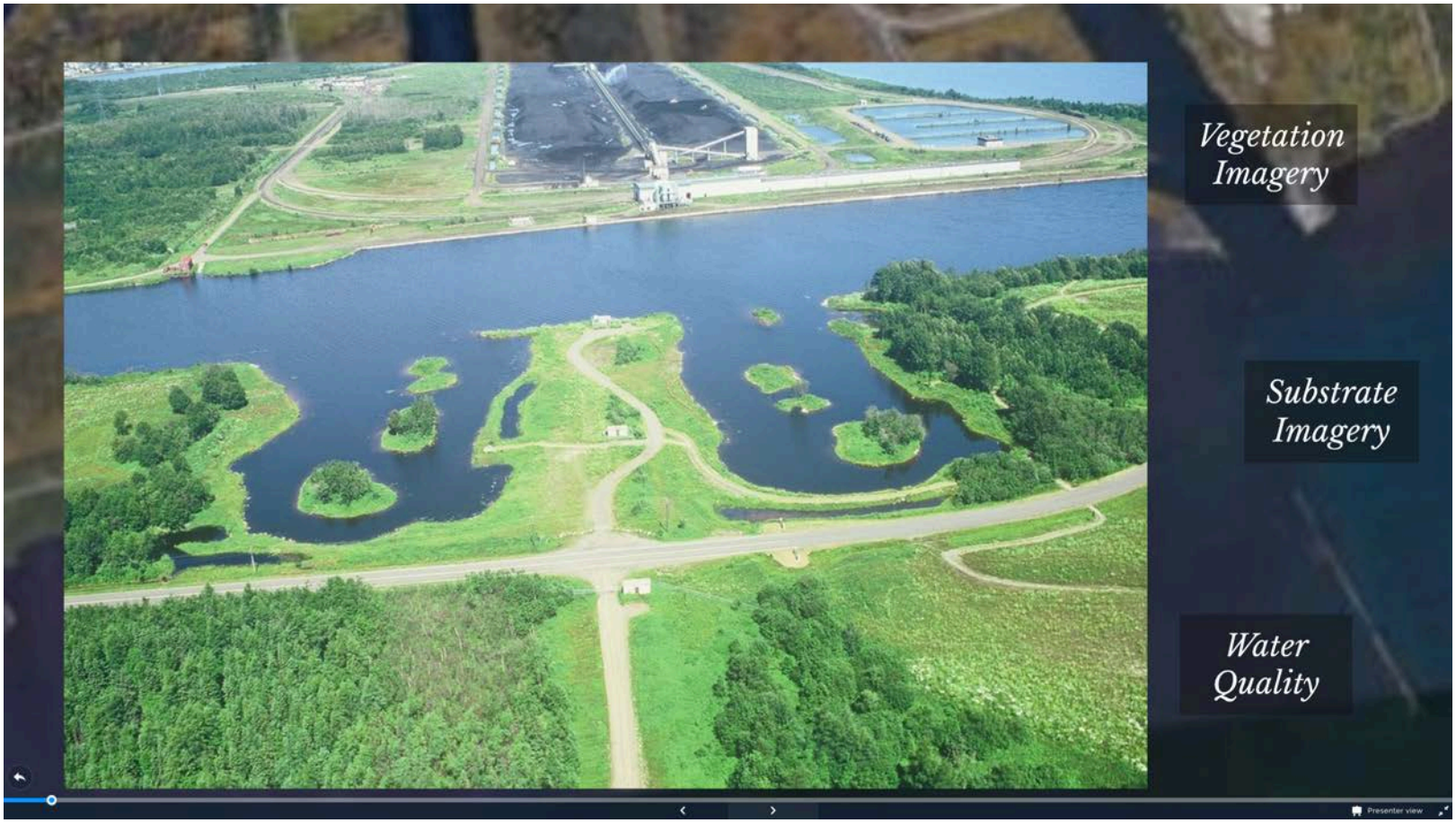
A Physical and Spatial Assessment of Remediated Submerged Habitats within the Thunder Bay Area of Concern

By: Michelle Willows

Habitat Rating Classes Based on Biophysical Parameters		
Class	**Range**	**Total**
Minimal Value	6-9	Habitat not considered important to ecological functioning of the watershed, with minimal fishery values. Limited contributions exist but are not sensitive to development.
Moderate Value	10 -14	Important to the ecological functioning of the watershed or estuary. Direct contributions to fishery values are limited.
High Value	15-19	Valuable to ecological functioning and contributes significantly to fishery values, but is not necessarily rare or pristine
Highest Value	20-23	Highly valuable to ecological functioning, contributes significantly to fishery values. Considered pristine or locally rare



McKellar Embayments



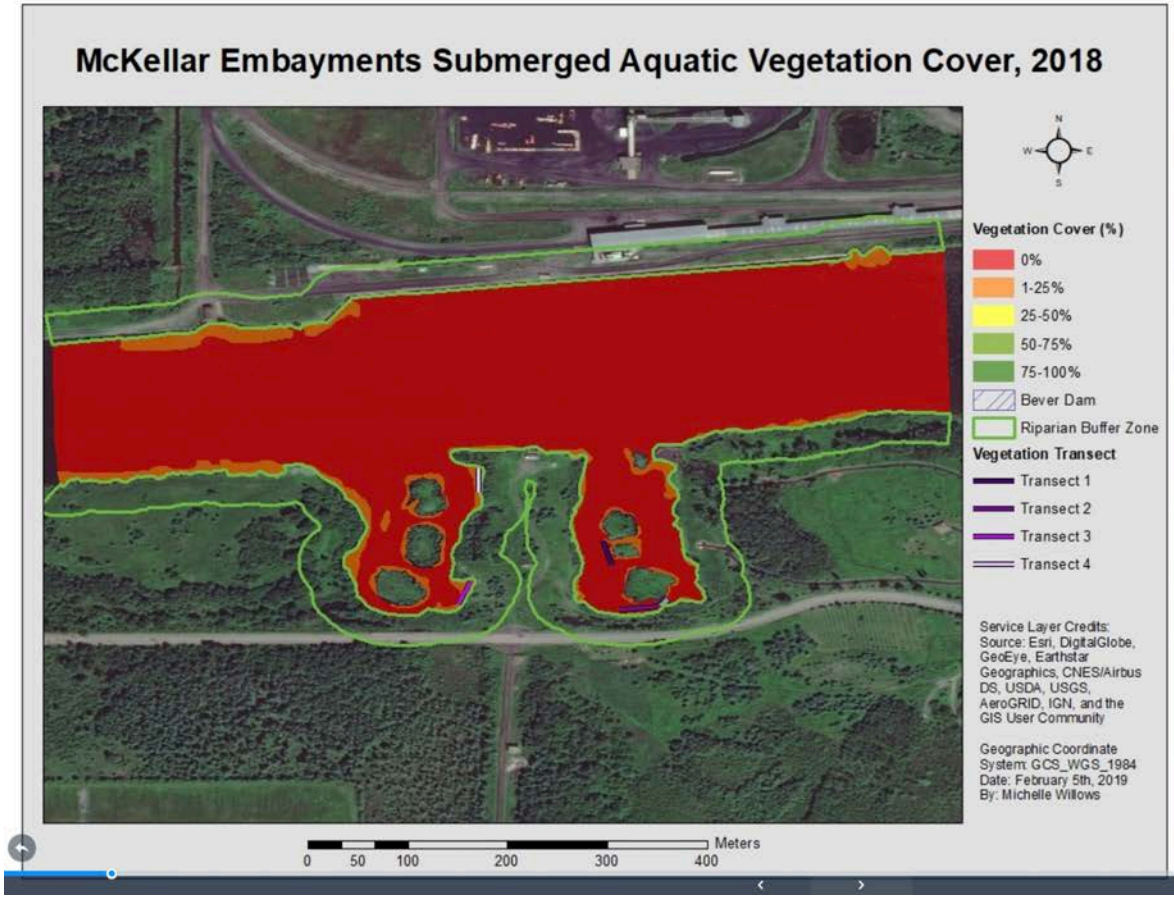
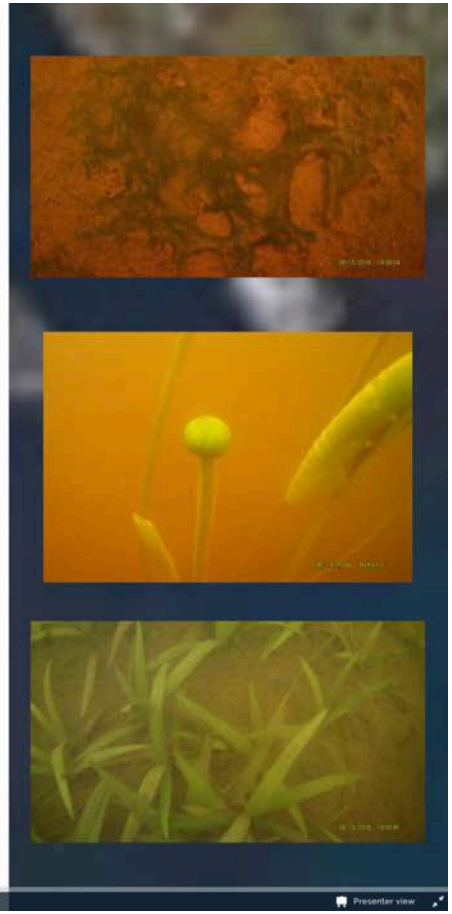
McKellar Embayments

McKellar Embayments Ranking and Classification Based on Habitat Values			
Habitat Characteristics	**Rating**	**Criteria**	**Score**
WMI and Species Count	Moderate	- Neutral U Values (2-3) and T-Values (1-2) - Moderate Species Diversity, <10 species.	2
Species Density	Low	- Low density (Sparse = 1-25%) -Encrusting algae indicates low flow and stagnant conditions.	1
Substrate	Low	- The aquatic habitat is man-made with little sub surface complexity. - Sedimentation with within quiescent waters led to a fine grained, silty-loam substrate. - Banks are riprap and have a high gradient.	1
Water Quality	High	- Sustainable temperature 15-19.9 ºC for diversification of species. - pH level range 6.5-7.5, ideal for aquatic biota. - High dissolved oxygen levels >7mg/L	4
Turbidity	Low	- High turbidity ranging from 35-54cm, detrimental to most aquatic biota. - Unfavourable to aquatic macrophytes due to lack of photosynthesis.	1
Habitat Buffer Zone	Moderate	- Meets the required 30m buffer, but otherwise surrounded by imperious surfaces, residential industrial activity.	3
		Total Score	13
Habitat Ranking and Classification	**Moderate Value:** Important to the ecological functioning of the watershed or estuary. Direct contributions to fishery values are limited.		

Vegetation Imagery

Substrate Imagery

Water Quality

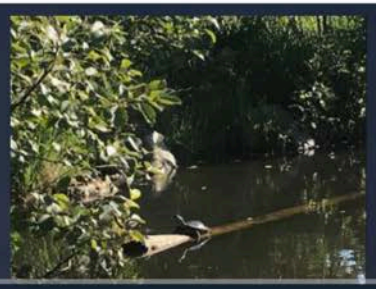

McKellar Embayments Submerged Aquatic Vegetation Cover, 2018
N
W
E
S
Vegetation Cover (%)
0%
1-25%
25-50%
50-75%
75-100%
Bever Dam
Riparian Buffer Zone
Vegetation Transect
Transect 1
Transect 2
Transect 3
Transect 4
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Geographic Coordinate System: GCS_WGS_1984
Date: February 5th, 2019
By: Michelle Willows
Meters
0 50 100 200 300 400

Presenter view

McKellar Embayments Bottom Composition
E2 Relative Hardness Echo Return

McKellar Embayments

Water Quality

Transect #	Date	Temperature (C°)	mmHg	DO %L	DO mg/L	DO ppm	SPC	pH	ORP mV
Spring									
T1	2018-07-08	14.4	745.2	99.3	9.98	9.98	123.9	7.14	339.3
T2	2018-07-08	14	745	94.6	9.45	9.45	125.8	7.13	332.3
T3	2018-07-08	15	745.2	82	8	8	148	7.22	155
T4	2018-07-08	16	745	96.5	9.36	9.36	121.6	7.53	204.3
Fall									
T1	2018-09-13	18.2	745.5	96	8.75	8.75	148.7	7.55	322.6
T2	2018-09-13	17.8	745.6	91.5	8.55	8.55	147.8	7.44	328.5
T3	2018-09-13	19	745.6	88.4	8.78	8.78	149.1	7.83	308.6
T4	2018-09-13	18	745.5	88.4	8.2	8.2	147	7.48	329.2



Neebing McIntyre Floodway

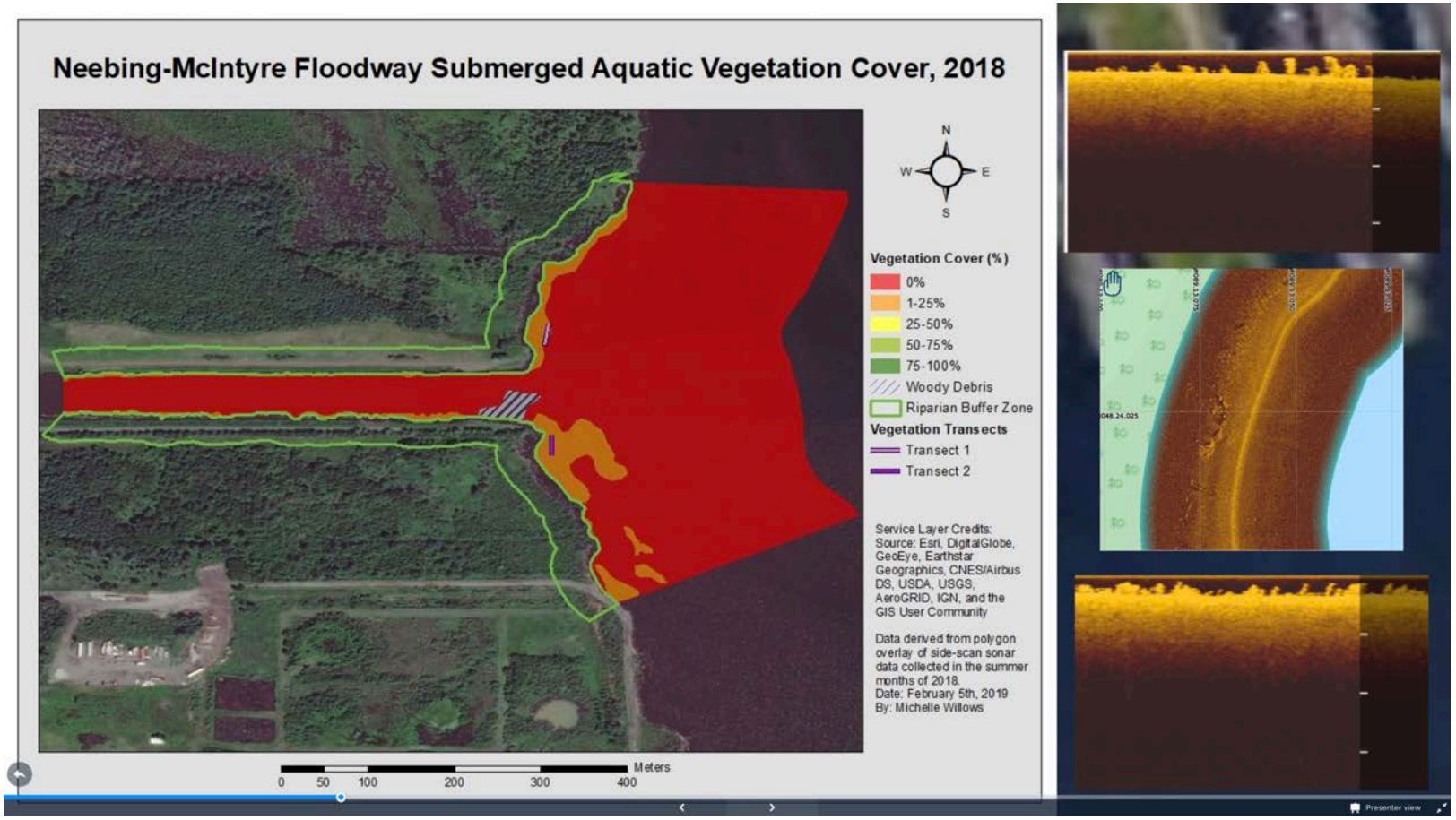
Neebing - McIntyre Floodway

Neebing – McIntyre Ranking and Classification Based on Habitat Values			
Habitat Characteristics	**Rating**	**Criteria**	**Score**
WMI and Species Count	Low	- Low U Values (1) and T Values (1). - Low species diversity, <5 species. - Only 3 species encountered, that are typically have a high tolerance and broad niche.	1
Species Density	Low	- Low density (Sparse = 1-25%), limited to a <2m strip within the littoral zone.	1
Substrate	Low	- Silty-clay within the river channel, with sand along either side of the delta. -Substrates poor for vegetation rooting, limiting growth or stability due to its mobility in current and wave action.	1
Water Quality	Moderate	- Sustainable temperatures 10-14.9 ºC, ideal for pelagic fish, specifically the family Salmonidae. -pH remained neutral throughout the season, remaining slightly below 7.5. - Good dissolved oxygen levels 6g/L -7mg/L	3
Turbidity	Low	- High turbidity ranging from 35-54cm, detrimental to most aquatic biota.	1
Habitat Buffer Zone	Fair	- Close to achieving 30m minimum buffer, with patch's or gaps of missing vegetation due to brown zones. - Paved walkways along the stream can increase surface runoff.	2
		Total Score	9
Habitat Ranking and Classification	**Minimal Value:** Habitat not considered important to ecological functioning of the watershed, with minimal fishery values. Limited contributions exist but are not sensitive to development.		

Vegetation Imagery

Substrate Imagery

Water Quality

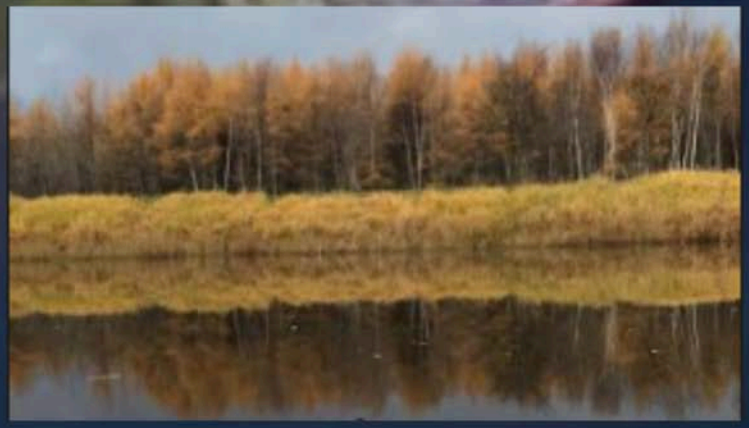

Neebing-McIntyre Floodway Submerged Aquatic Vegetation Cover, 2018
N
W
E
S
Vegetation Cover (%)
0%
1-25%
25-50%
50-75%
75-100%
Woody Debris
Riparian Buffer Zone
Vegetation Transects
Transect 1
Transect 2
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Data derived from polygon overlay of side-scan sonar data collected in the summer months of 2018.
Date: February 5th, 2019
By: Michelle Willows
Meters
0
50
100
200
300
400
Presenter view

Neebing - McIntyre Bottom Composition
E2 Relative Hardness Echo Return

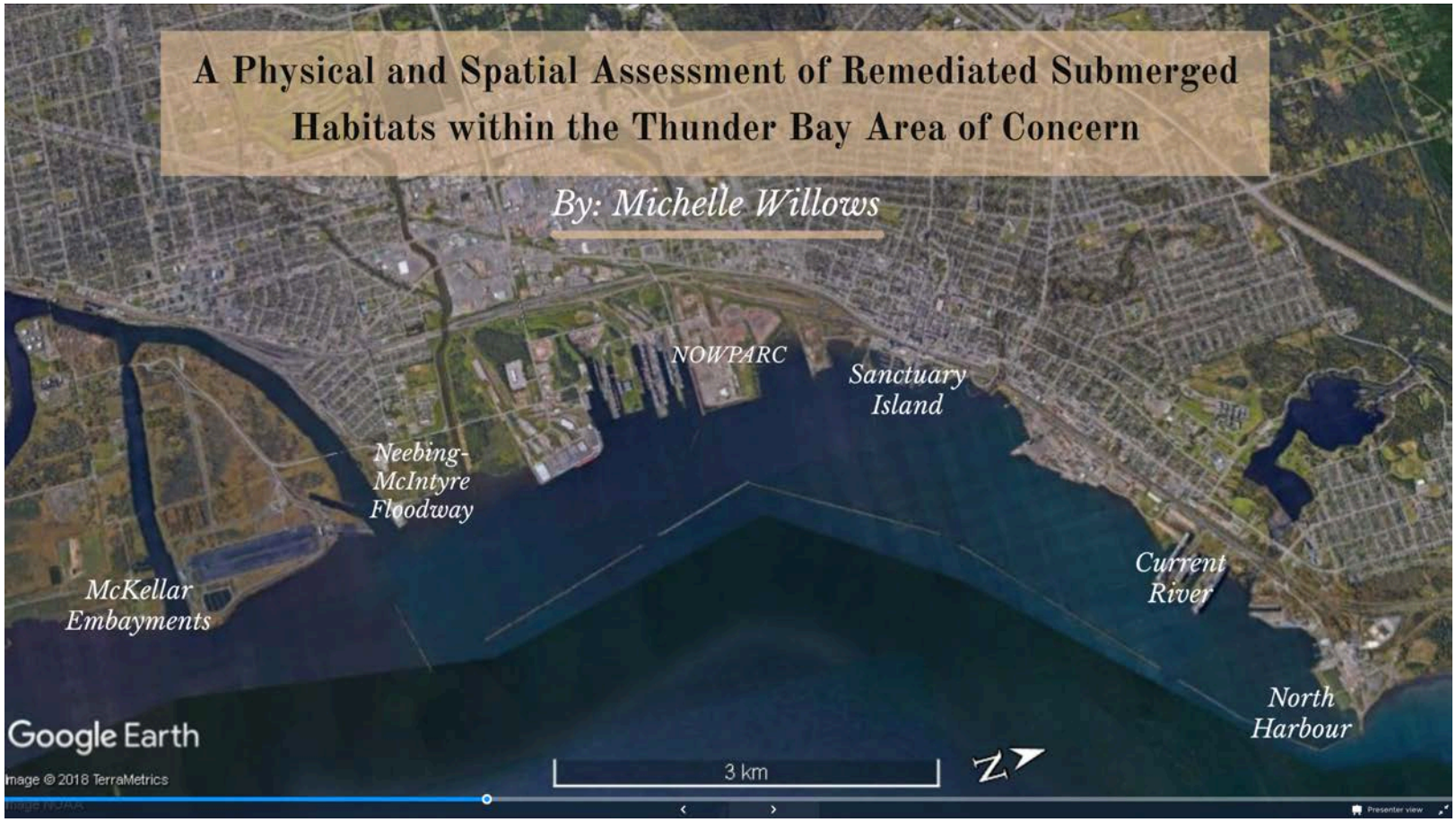
Imagery Provided by ©Google Earth and ReefMaster Software.

Neebing McIntyre Floodway

Water Quality



Transect #	Date	Temperature (C°)	mmHg	DO %L	DO mg/L	DO ppm	SPC	pH	ORP mV
Spring									
T1	2018-07-13	19.8	744.5	79.7	7.13	7.13	364.7	7.39	349.7
T2	2018-07-13	19.8	744.4	83.6	7.5	7.5	364.7	7.49	346.2
Fall									
T1	2018-10-25	6.1	746.6	108	13.18	13.18	127.3	7.22	303.3
T2	2018-10-25	5.4	746.5	103.7	12.86	12.86	168.6	7.26	297.5


A Physical and Spatial Assessment of Remediated Submerged Habitats within the Thunder Bay Area of Concern
By: Michelle Willows
NOWPARC
Sanctuary Island
Neebing-McIntyre Floodway
McKellar Embayments
Current River
North Harbour
Google Earth
Image © 2018 TerraMetrics
3 km
N

NOWPARC


Northern Wood Preservers Alternative Remediation Concept
Vegetation Imagery
Substrate Imagery
Water Quality
Presenter view

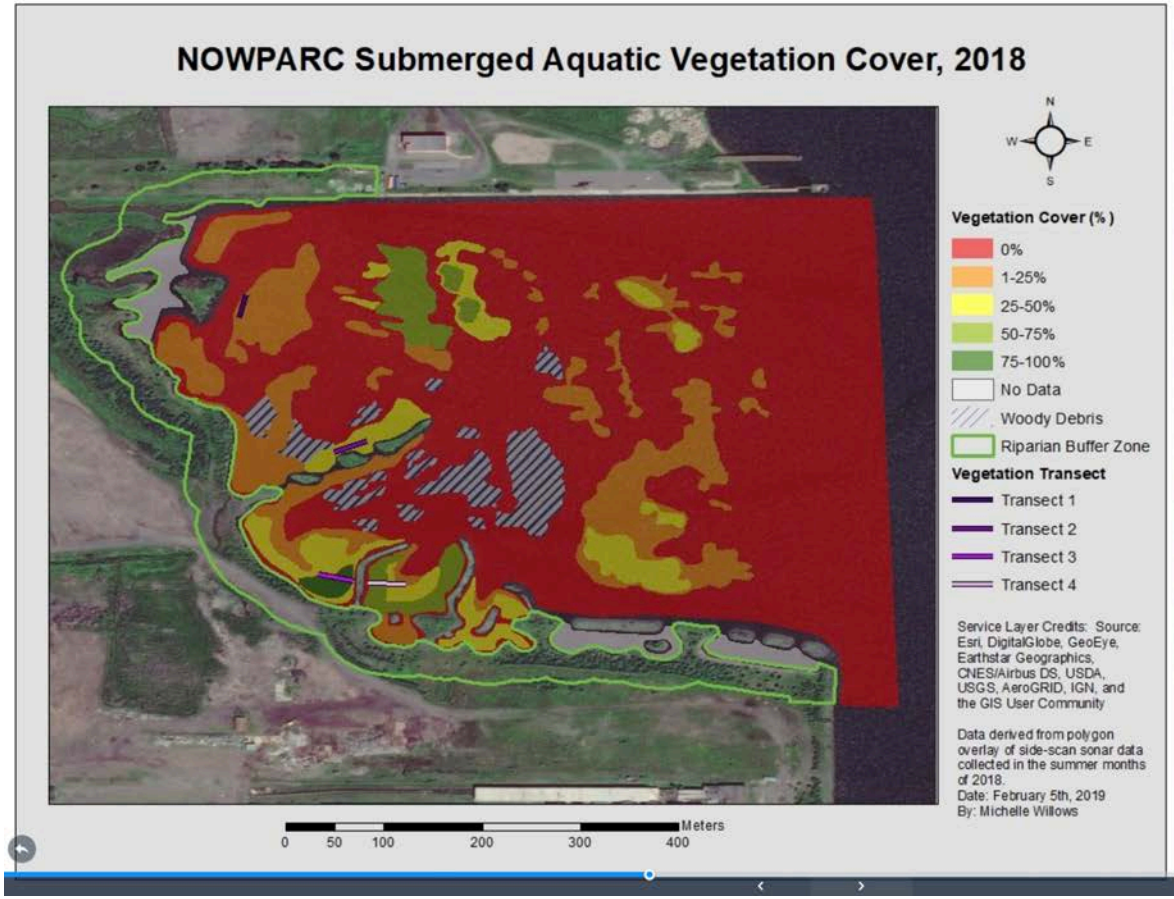
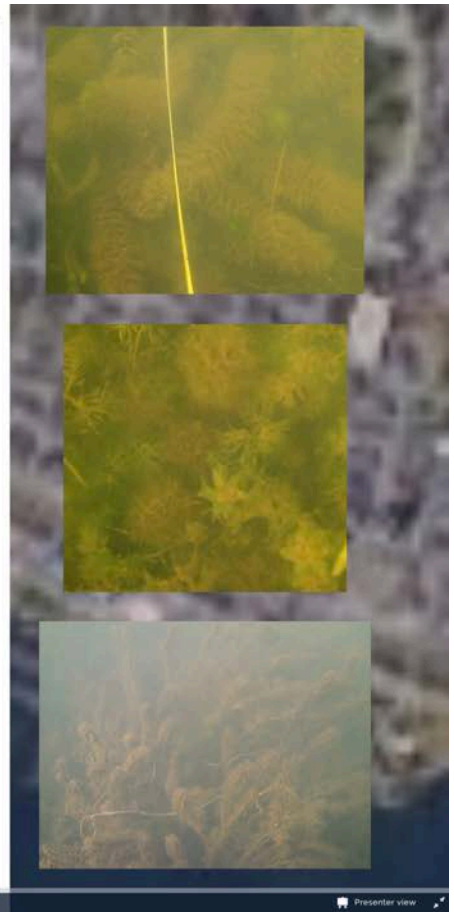
Northern Wood Preservers Alternative Remediation Concept

NOWPARC Ranking and Classification Based on Habitat Values			
Habitat Characteristics	**Rating**	**Criteria**	**Score**
WMI and Species Count	High	- High U Values (3-4) and T-Values (2) - High species diversity <15 species. The NOWPARC location had the highest recorded diversity in submerged macrophytes with 15 species identified.	3
Vegetation Density	High	- Vegetation density ranging from 50-75% along transects.	3
Substrate	High	- Diverse substrate structure encompassing sediments ideal for plants, cobble, small boulders and woody debris to encourage cultivation of invertebrates. - Adequate siltation within the berms has promoted a high diversity of plants. - Porous enough to promote strong rooting.	3
Water Quality	High	- Sustainable temperature 15-19.9 ºC for diversification of species. - pH level range 6.5-7.5, ideal for aquatic biota. - High dissolved oxygen levels >7mg/L	4
Turbidity	Moderate	- Low Turbidity 70-99cm, with only slight turbidity after a precipitation event.	3
Habitat Buffer Zone	Fair	-Riparian buffer zone is not consistent around habitat. - Riparian zone varies in thickness, the western shore has >60m of habitat, however where are the south western shoreline is <15m.	2
		Total Score	18
Habitat Ranking and Classification	**High Value:** Valuable to ecological functioning and contributes significantly to fishery values, but is not necessarily rare or pristine.		

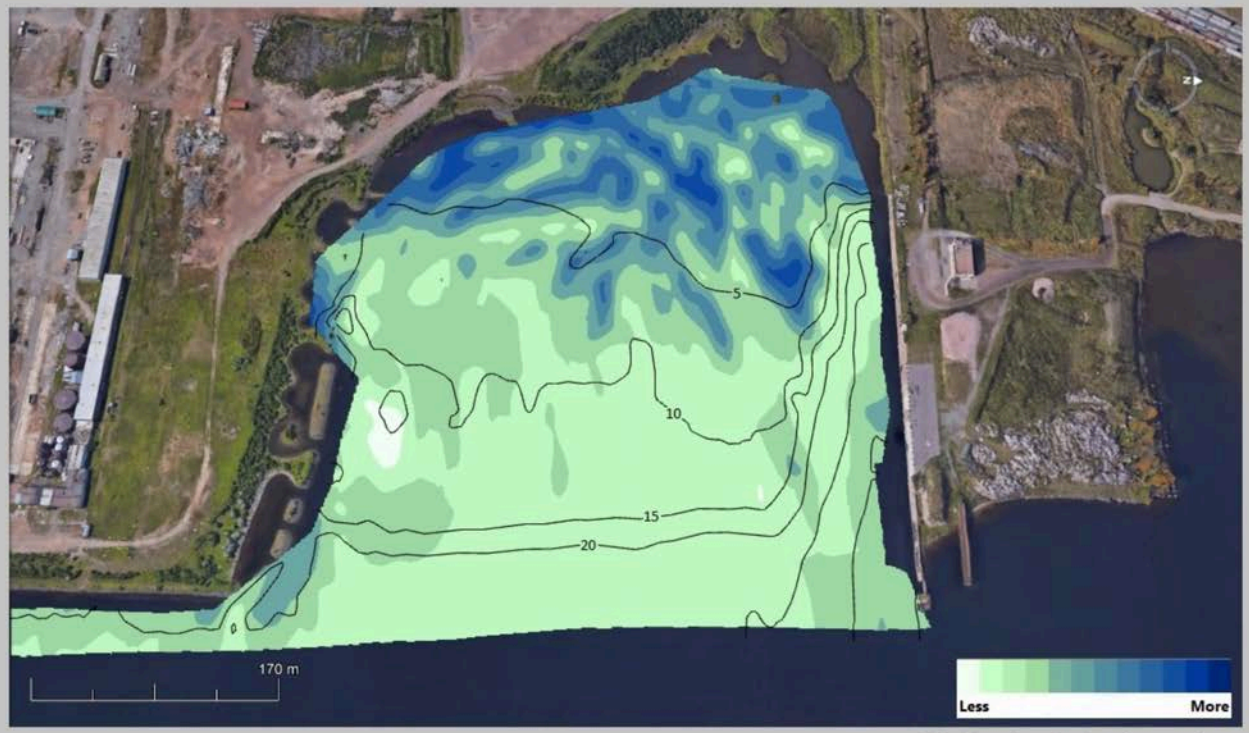
Vegetation Imagery

Substrate Imagery

Water Quality

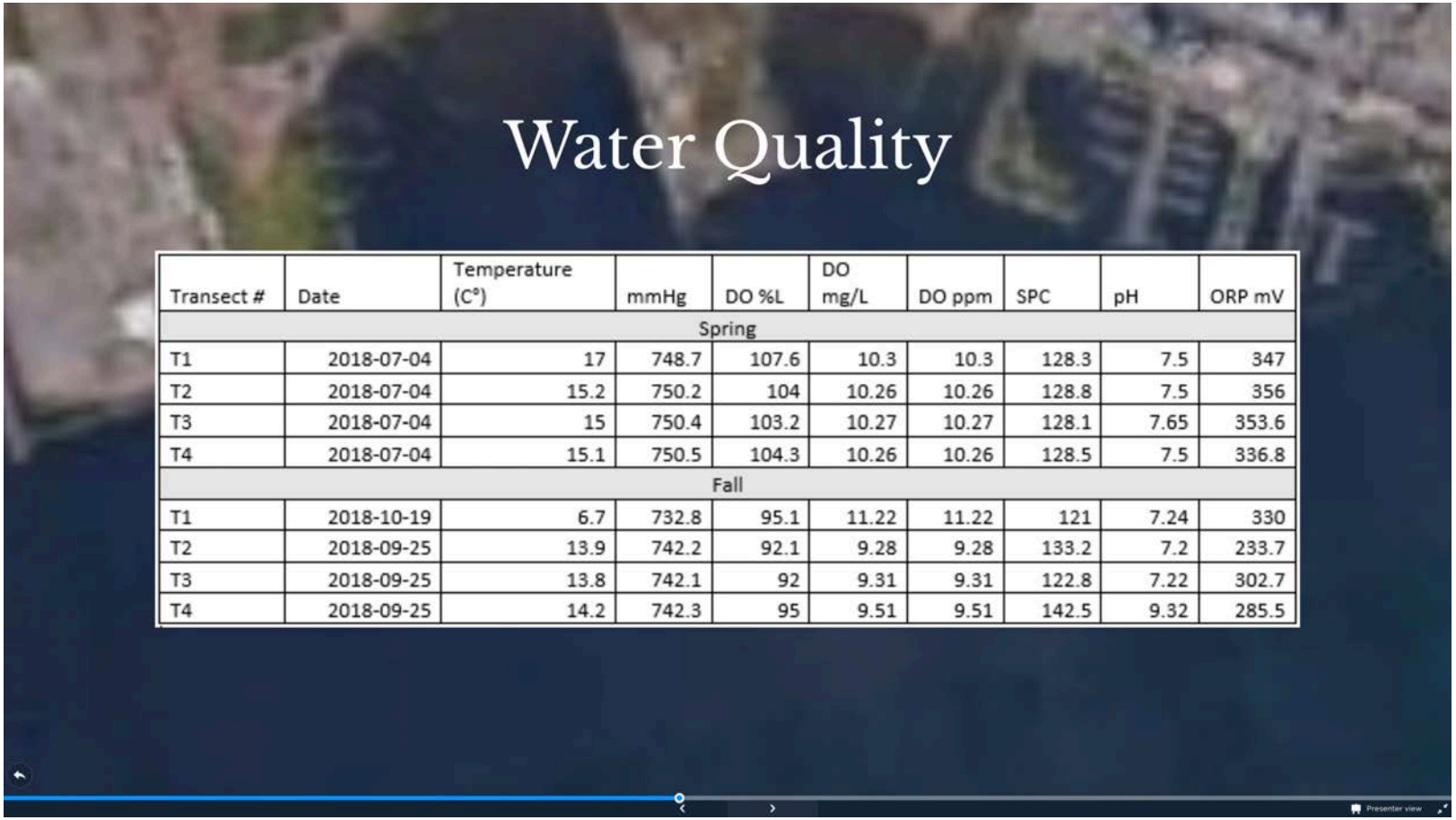

NOWPARC Submerged Aquatic Vegetation Cover, 2018
N
W
E
S
Vegetation Cover (%)
0%
1-25%
25-50%
50-75%
75-100%
No Data
Woody Debris
Riparian Buffer Zone
Vegetation Transect
Transect 1
Transect 2
Transect 3
Transect 4
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Data derived from polygon overlay of side-scan sonar data collected in the summer months of 2018.
Date: February 5th, 2019
By: Michelle Willows
0 50 100 200 300 400
Meters


NOWPARC Bottom Composition
E2 Relative Hardness Echo Return

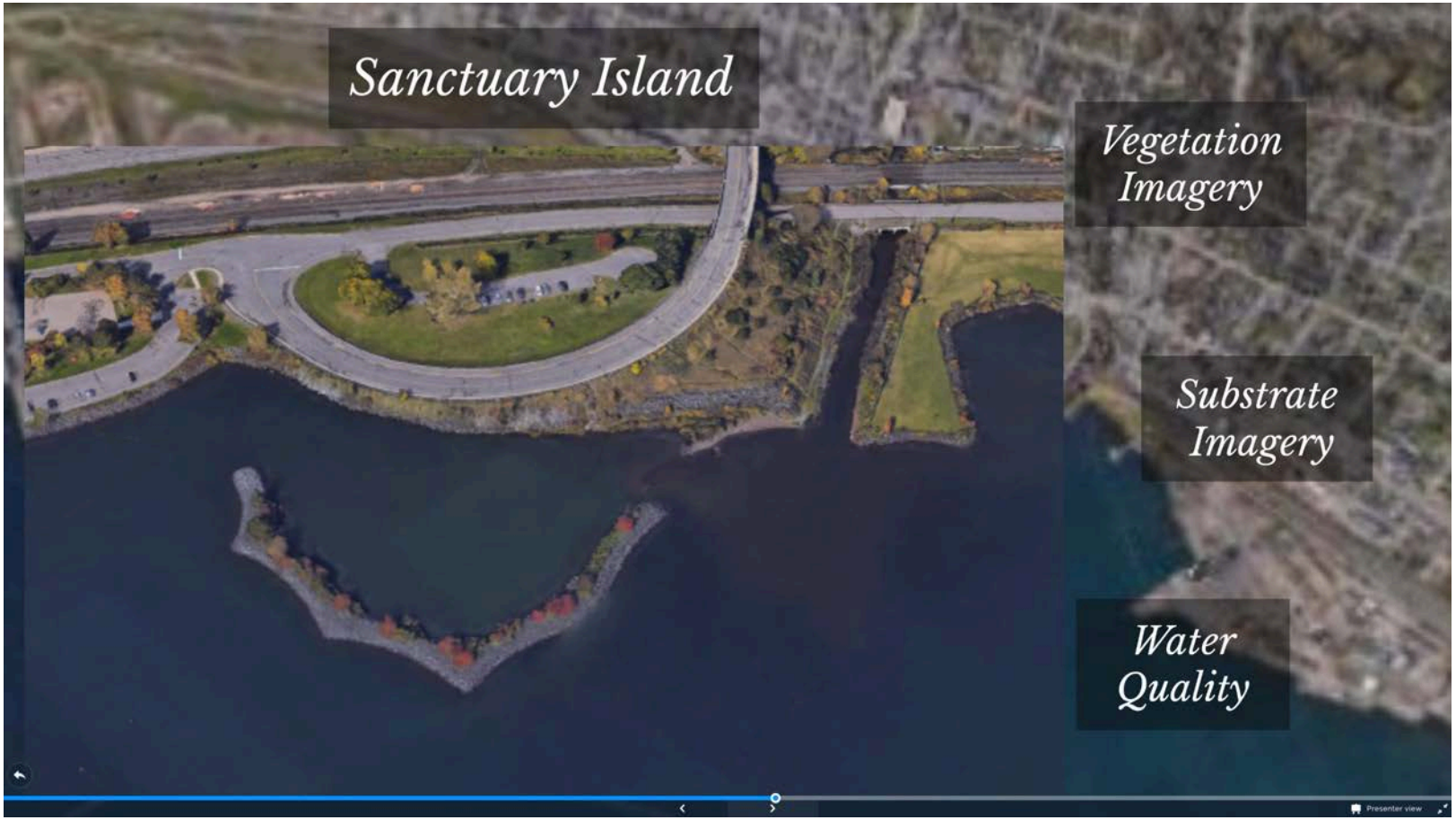


Imagery Provided by ©Google Earth and ReefMaster Software.

NOWPARC



Transect #	Date	Temperature (C°)	mmHg	DO %L	DO mg/L	DO ppm	SPC	pH	ORP mV
Spring									
T1	2018-07-04	17	748.7	107.6	10.3	10.3	128.3	7.5	347
T2	2018-07-04	15.2	750.2	104	10.26	10.26	128.8	7.5	356
T3	2018-07-04	15	750.4	103.2	10.27	10.27	128.1	7.65	353.6
T4	2018-07-04	15.1	750.5	104.3	10.26	10.26	128.5	7.5	336.8
Fall									
T1	2018-10-19	6.7	732.8	95.1	11.22	11.22	121	7.24	330
T2	2018-09-25	13.9	742.2	92.1	9.28	9.28	133.2	7.2	233.7
T3	2018-09-25	13.8	742.1	92	9.31	9.31	122.8	7.22	302.7
T4	2018-09-25	14.2	742.3	95	9.51	9.51	142.5	9.32	285.5


Sanctuary Island
Vegetation Imagery
Substrate Imagery
Water Quality
Presenter view

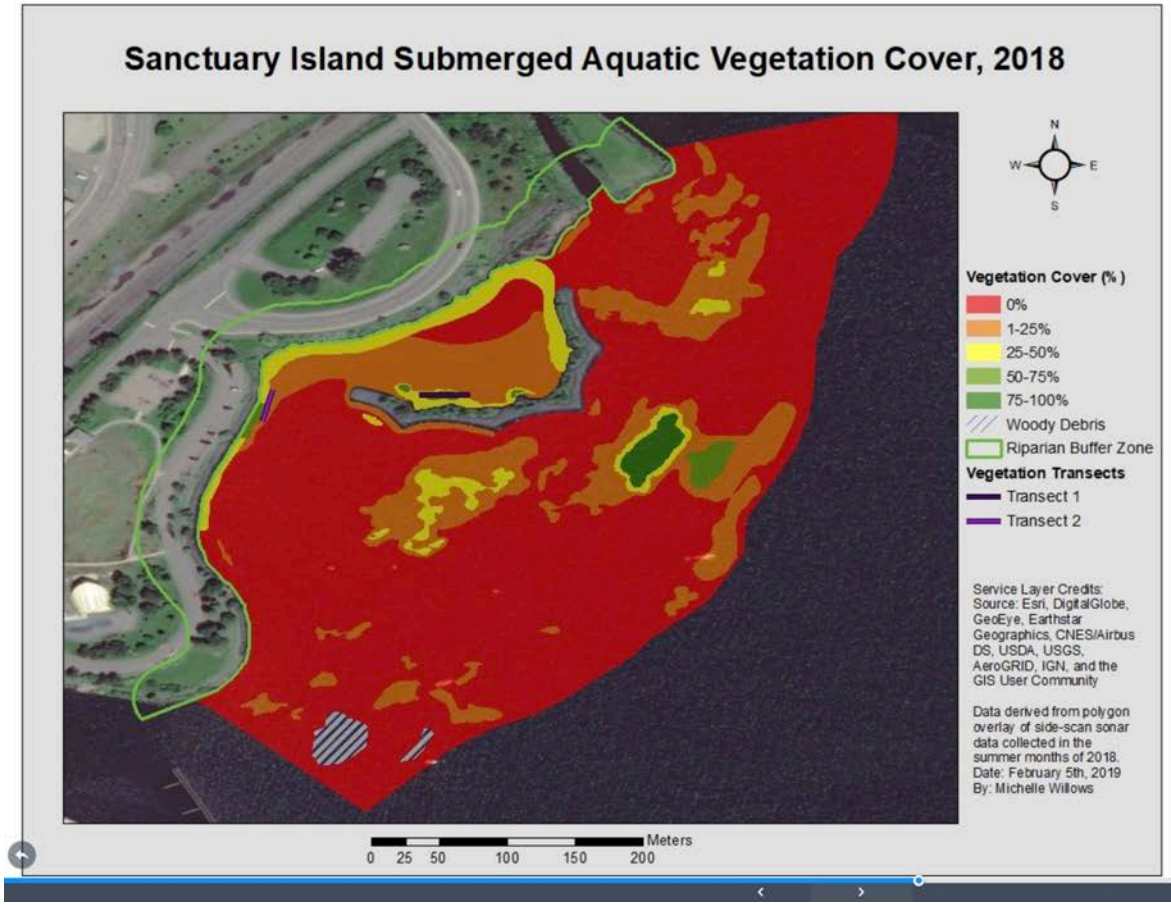
Sanctuary Island

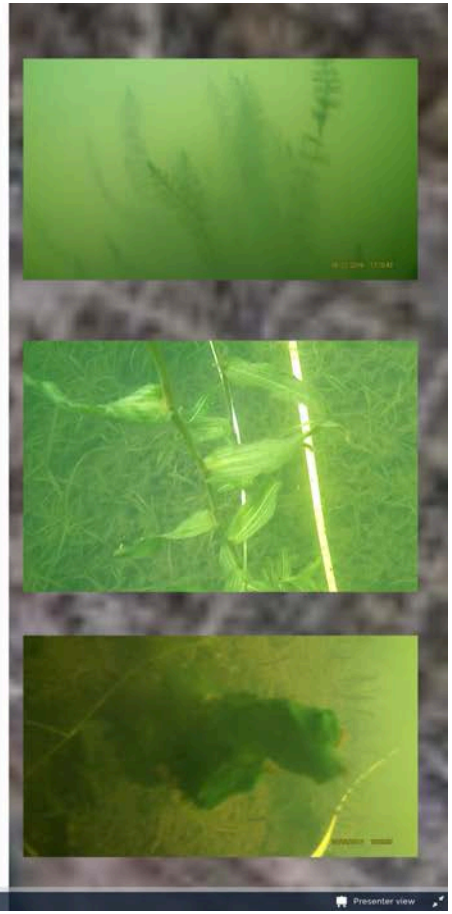
Sanctuary Island Ranking and Classification Based on Habitat Values			
Habitat Characteristics	**Rating**	**Criteria**	**Score**
WMI and Species Count	High	- High U Values (3-4) and T-Values (2) - High species diversity <15 species. - Vegetation within the crescent berm ranked lower in tolerance and niche breadth, showing inconsistences through out the aquatic habitat.	3
Species Density	Moderate	- Vegetation ranged from 25-50% along the inner crescent, increased to 50-75% within the opening channel.	2
Substrate	Low	- The substrate directly within the berm wall consisted of fine grained silty-loam, it was easily disturbed and loosely packed. - Substrate within the channel and in front of the berm consisted of a sandy-silt which cultivated more growth.	1
Water Quality	High	- Sustainable temperatures 10-14.9 ºC, ideal for pelagic fish, specifically the family Salmonidae. - pH levels between 8-9, signifies intense photosynthetic activity. - Good dissolved oxygen levels 6g/L -7mg/L	3
Turbidity	Fair	- Fairly turbid water, 55-69cm, within the crescent island, increasing 70 to 99cm within the island opening.	2
Habitat Buffer Zone	Low	- Little to no buffer. - Large amounts of impervious surfaces (parking, roads and the overpass) increasing runoff.	1
		Total Score	12
Habitat Ranking and Classification	**Moderate Value:** Important to the ecological functioning of the watershed or estuary. Direct contributions to fishery values are limited .		

Vegetation Imagery

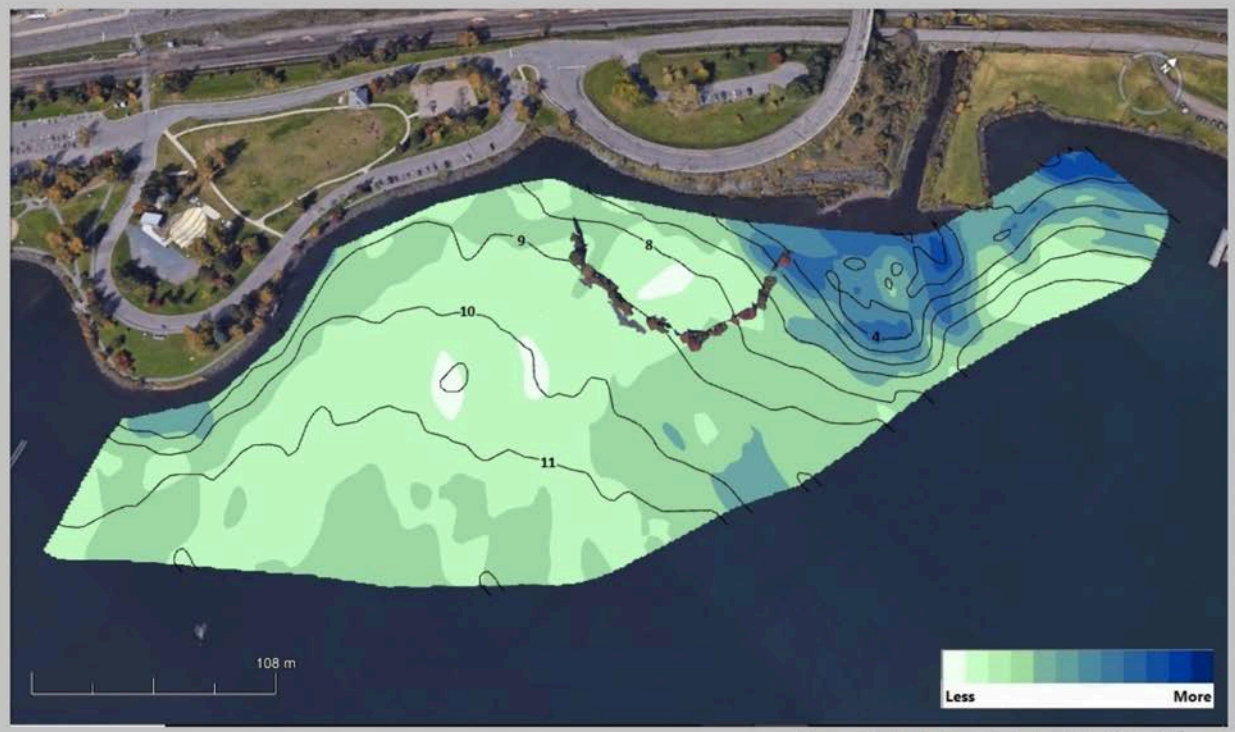
Substrate Imagery

Water Quality


Sanctuary Island Submerged Aquatic Vegetation Cover, 2018
N
W
E
S
Vegetation Cover (%)
0%
1-25%
25-50%
50-75%
75-100%
Woody Debris
Riparian Buffer Zone
Vegetation Transects
Transect 1
Transect 2
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Data derived from polygon overlay of side-scan sonar data collected in the summer months of 2018.
Date: February 5th, 2019
By: Michelle Willows
0 25 50 100 150 200
Meters



Sanctuary Island Bottom Composition
E2 Relative Hardness Echo Return

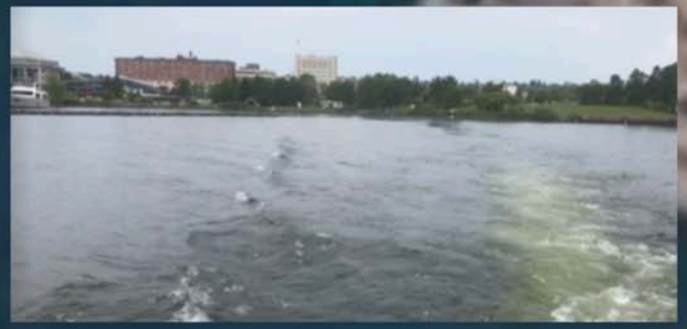


Imagery Provided by ©Google Earth and ReefMaster Software.

Sanctuary Island

Water Quality

Transect #	Date	Temperature (C°)	mmHg	DO %L	DO mg/L	DO ppm	SPC	pH	ORP mV
Spring									
T1	2018-06-28	19	740.4	115	10.25	10.25	138.3	8	335.9
T2	2018-06-28	18.5	740.5	113	10.3	10.3	135.5	8.2	330.4
Fall									
T1	2018-10-19	6.6	733.1	96.7	11.45	11.45	126	7.08	344.7
T2	2018-10-19	6.7	733.2	93.2	10.99	10.99	133.1	7.14	340.9




Current River
Vegetation Imagery
Substrate Imagery
Water Quality

Current River

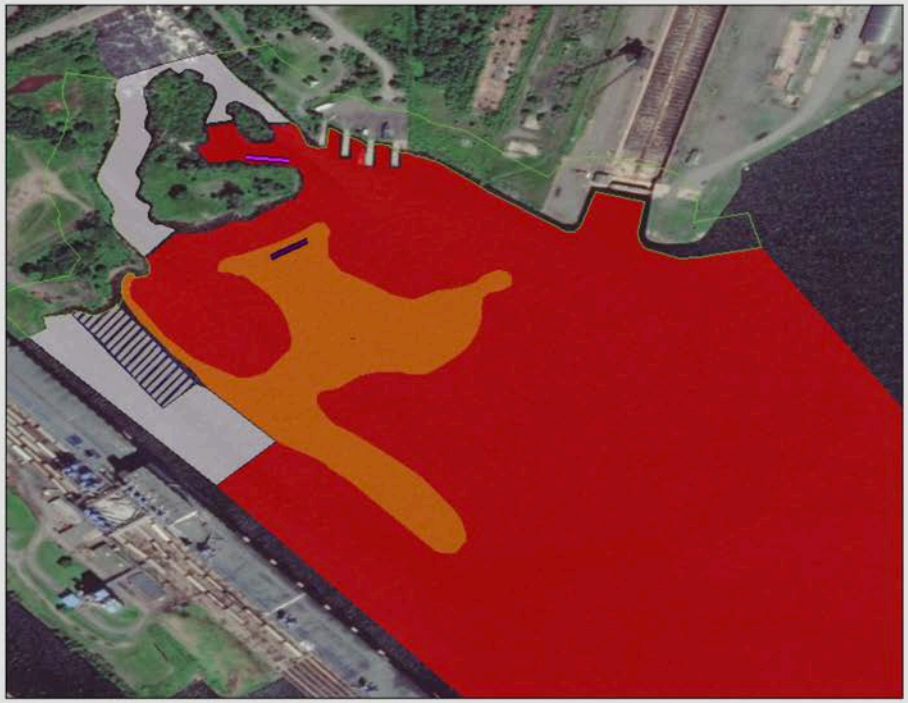
Current River Classification Based on Habitat Values			
Habitat Characteristics	**Rating**	**Criteria**	**Score**
WMI and Species Count	Low	- Low U Values (1) and T Values (1). - Low species diversity, <5 species.	1
Vegetation Density	Low	- Low density (Sparse = 1-25%), which is characteristically correct due to the locations velocity and flow rates.	1
Substrate	Low	- Clean cobble substrate for river systems OR silty sand with high nutrient content. - Floodway and the large portions of cobble provide a good habitat for periphyton and invertebrates.	3
Water Quality	Excellent	- Sustainable temperature 15-19.9 ºC for diversification of species. - pH level range 6.5-7.5, ideal for aquatic biota. - High dissolved oxygen levels >7mg/L	4
Turbidity	Moderate	- Low Turbidity 70-99cm	3
Habitat Buffer Zone	Moderate	- Meets the required 30m buffer, but otherwise surrounded by imperious surfaces, residential industrial activity. - Buffer zone broken up by hardened, impermeable shoreline due to roadways, parking lots and docking.	3
		Total Score	15
Habitat Ranking and Classification	**High Value:** Valuable to ecological functioning and contributes significantly to fishery values, but is not necessarily rare or pristine.		

Vegetation Imagery

Substrate Imagery

Water Quality

Current River Submerged Aquatic Vegetation Cover, 2018



N
W E
S

Vegetation Cover (%)

- 0%
- 1-25%
- 25-50%
- 50-75%
- 75-100%
- Woody Debris
- No Data
- Riparian Buffer Zone

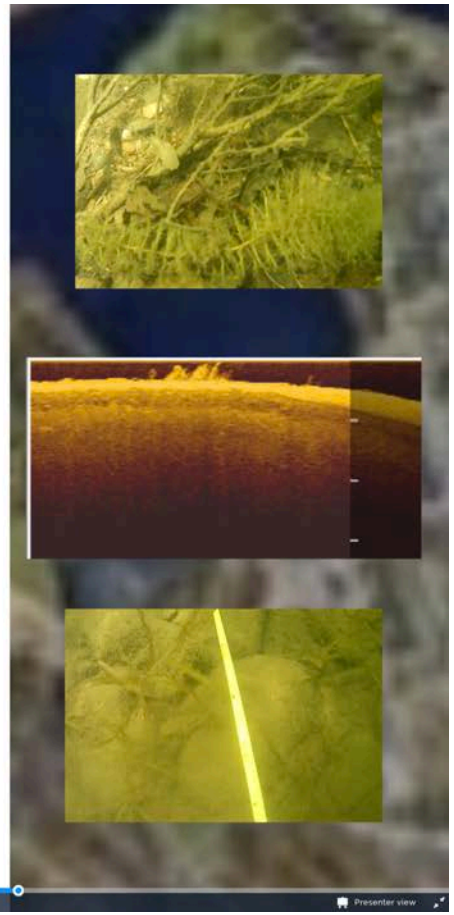
Vegetation Transect

- Transect 1
- Transect 2

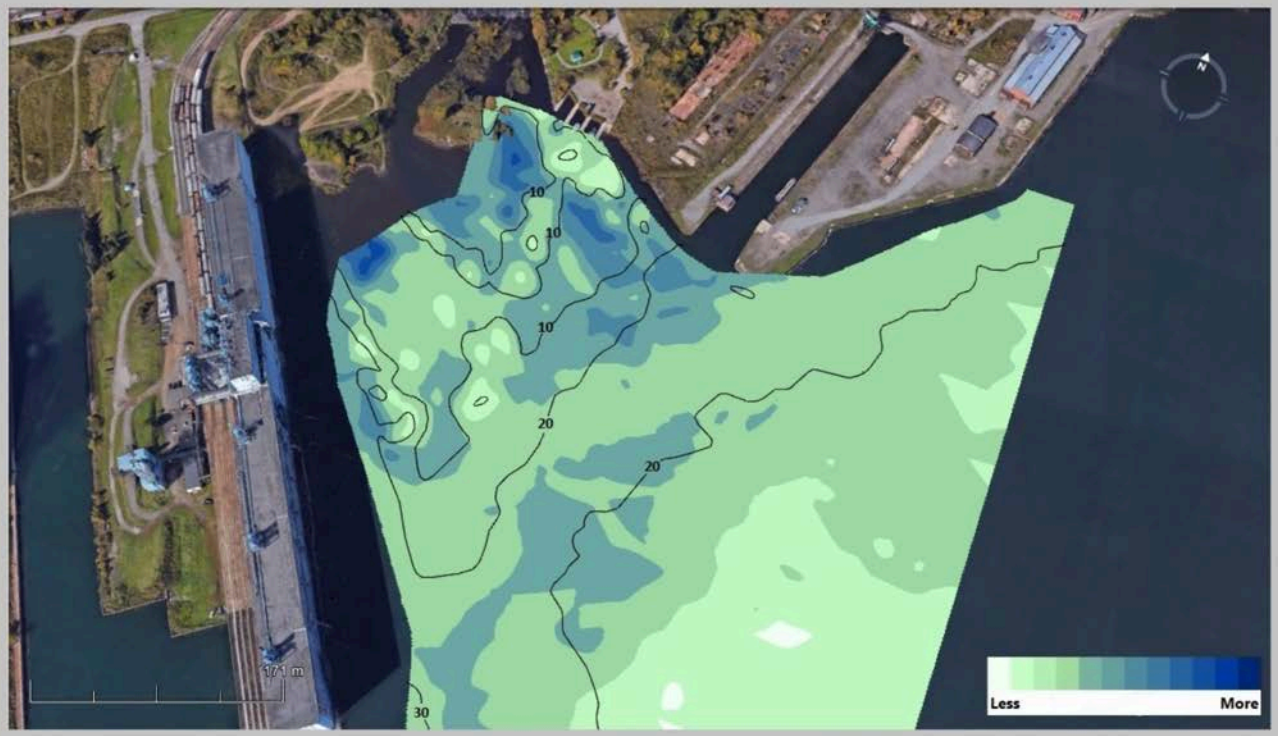
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Data derived from polygon overlay of side-scan sonar data collected in the summer months of 2018.
Date: February 5th, 2019
By: Michelle Willows

0 25 50 100 150 200 Meters



Current River Bottom Composition
E2 Relative Hardness Echo Return



Current River

Water Quality

Transect #	Date	Temperature (C°)	mmHg	DO %L	DO mg/L	DO ppm	SPC	pH	ORP mV
Spring									
T1	2018-06-26	17.3	745.8	108.5	10.6	10.6	114.6	7.6	331.1
T2	2018-06-26	20.8	745.9	94.5	8.3	8.3	114	7.6	322.5
Fall									
T1	2018-09-13	18.4	748.1	95.9	8.83	8.83	134.75	7.66	316.2
T2	2018-09-13	18.7	748	92.3	8.44	8.41	150.8	7.37	308.6


North Harbour
Thunder Bay Water Aerodrome
Approximate Area of Contaminated Sediment
Vegetation Imagery
Substrate Imagery
Water Quality
Presenter view

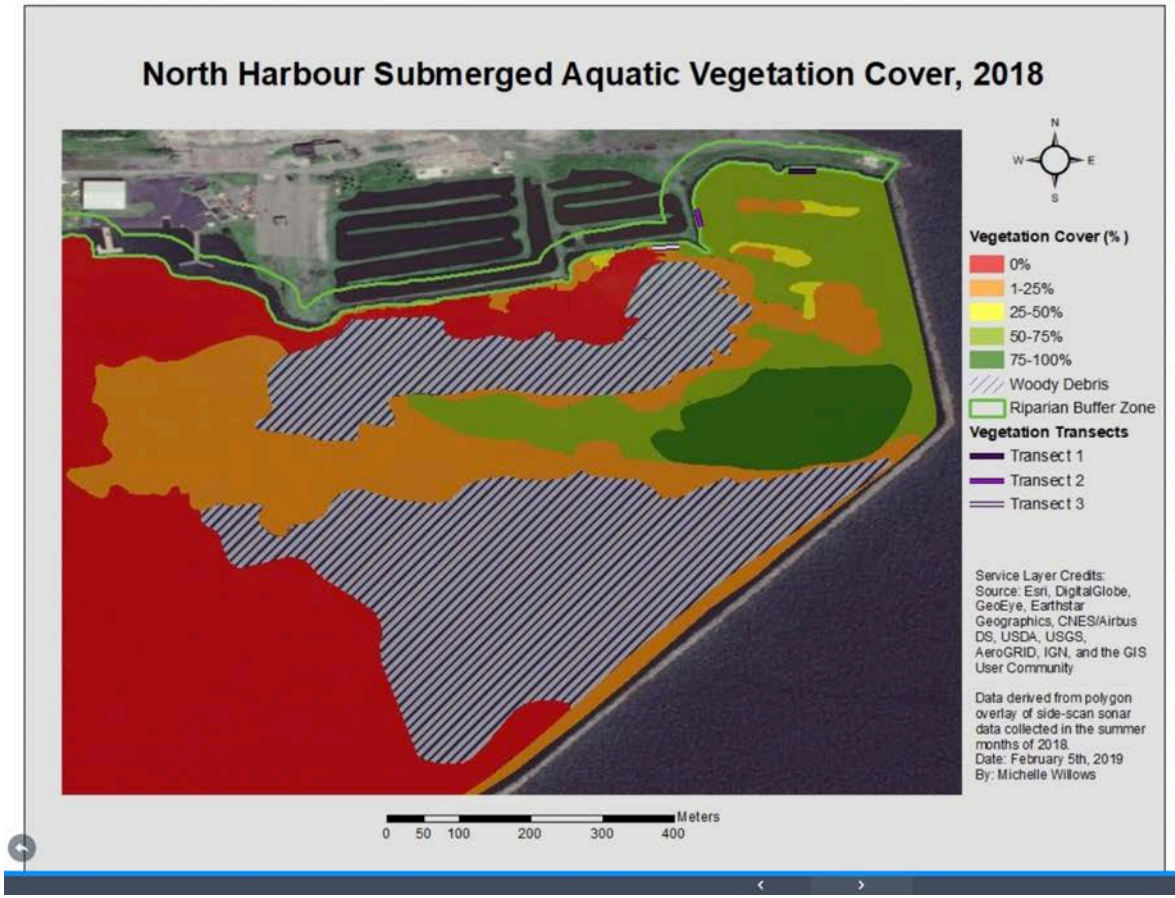
North Harbour

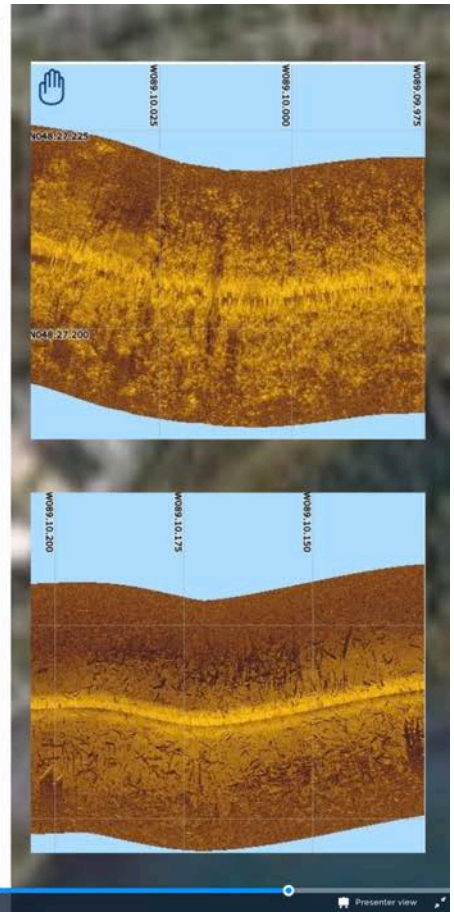
North Harbour Classification Based on Habitat Values			
Habitat Characteristics	**Rating**	**Criteria**	**Score**
WMI and Species Count	High	- High U Values (3-4) and T-Values (2) - High species diversity <15 species.	3
Vegetation Density	Excellent	- A varied range of densities from 50-75% and 75-100% creating a habitat with high complexity. - Large volumes of wood logs, from 2m to 8m logs were clustered throughout the location and lined the large area of vegetation.	4
Substrate	Low	- Pulp waste with presence of silty-clay, sand and gravel, substrates. - Substrates in front of lagoons is easily re-suspended increasing turbidity.	1
Water Quality	Excellent	- Sustainable temperature 15-19.9 ºC for diversification of species. - pH level range 6.5-7.5, ideal for aquatic biota. - High dissolved oxygen levels >7mg/L	4
Turbidity	Moderate	- Low Turbidity 70-99cm	3
Habitat Buffer Zone	Low	- Little to no buffer. - Large amounts of impervious surfaces due to roadways, parking lots and docking.	1
		Total Score	16
Habitat Ranking and Classification	**Minimal-Moderate Value:** The habitat currently has known Mercury contamination and experiences a high degree of anthropogenic interference. However, the location has potential to be valuable to ecological functioning and contributes significantly to fishery values due to its proximity to Current River. The habitat exhibits a high degree complexity, due to a diverse range of macrophytes and woody debris. Additionally the standardized water quality readings are ideal for a high diversification of species, both adult and juvenile.		

Vegetation Imagery

Substrate Imagery

Water Quality


North Harbour Submerged Aquatic Vegetation Cover, 2018
N
W
E
S
Vegetation Cover (%)
0%
1-25%
25-50%
50-75%
75-100%
Woody Debris
Riparian Buffer Zone
Vegetation Transects
Transect 1
Transect 2
Transect 3
Service Layer Credits: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community
Data derived from polygon overlay of side-scan sonar data collected in the summer months of 2018.
Date: February 5th, 2019
By: Michelle Willows
0 50 100 200 300 400
Meters

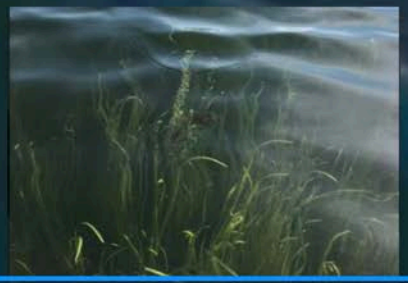

W089:10.025
W089:10.000
W089:09.975
N048:27:225
N048:27:200
W089:10.200
W089:10.175
W089:10.150
Presenter view

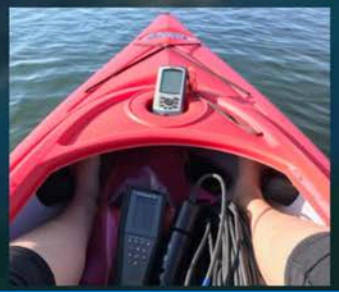
North Harbour Bottom Composition
E2 Relative Hardness Echo Return

North Harbour

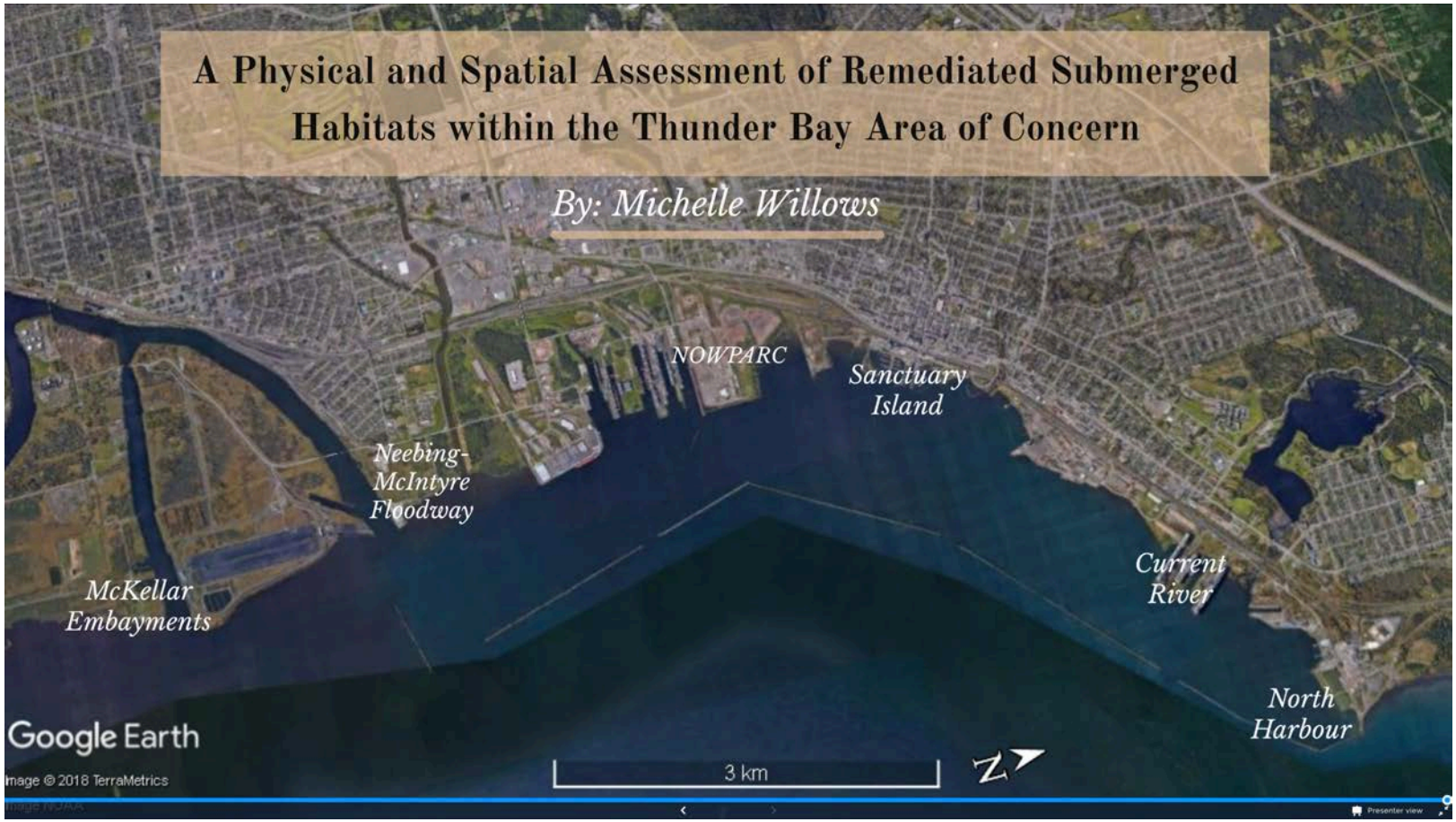
Water Quality

Transect #	Date	Temperature (C°)	mmHg	DO %L	DO mg/L	DO ppm	SPC	pH	ORP mV
Spring									
T1	2018-07-18	17.1	749.2	87.8	8.5	8.5	115.9	7.24	336.4
T2	2018-07-18	17.6	749.1	76.2	7.19	7.19	117.2	7.26	331.6
T3	2018-07-18	18.3	749	82	7.57	7.57	120.5	6.97	348.4
Fall									
T1	2018-09-13	17.3	748.2	90.3	8.67	8.67	116.6	7.6	297.4
T2	2018-09-13	17.6	748.2	92.3	8.69	8.69	116.8	7.33	201.2
T3	2018-09-13	16.9	748.3	87.6	86.3	8.22	116.4	7.08	319.7





Questions?


A Physical and Spatial Assessment of Remediated Submerged Habitats within the Thunder Bay Area of Concern
By: Michelle Willows
NOWPARC
Sanctuary Island
Neebing-McIntyre Floodway
McKellar Embayments
Current River
North Harbour
Google Earth
Image © 2018 TerraMetrics
3 km

RAP

NORTH SHORE OF LAKE SUPERIOR

REMEDIAL ACTION PLANS

InfoSuperior.ca